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AN EXTENSIVE PLANT OF COKE OVENS, on the Otto-Hoffman system, with apparatus for saving the by-products, is about to be erected at McKeesport, on the bank of the Monongahela River, 15 miles above Pittsburg, by the Otto Coke & Chemical Co., of Pittsburg. The location will be in close proximity to the National Tube Works, with which works a contract has been made to supply its boilers with the surplus gas from the ovens after the useful by-products have been extracted from it. It is estimated that the complete plant will cost about $1,000,000. According to figures given in a Pittsburg paper each oven of an Otto-Hoffman plant cost $2,766, and including the by-product saving appliances, $3,896. The plant will have a capacity of 660 tons of coke and 400,000 cu. ft. of gas in 24 hours. Connellsville coal can be coked in 21 and Pittsburg coal in 24 hours. From each ton of coal 4.2% of tar and 1.2% of ammonia is extracted. The Otto Coke & Chemical Co. is also negotiating with other iron manufacturing concerns with a view of putting up coke ovens with gas saving attachments in proximity to their works, and supplying these works with coke and with fuel gas. The introduction of the gas-saving coke oven into the iron manufacturing establishments of Pittsburg and vicinity is likely to effect a most important change in the cost of its iron and steel, and may some day cause it to become a comparatively smokeless city.

JAPANESE IRON DEPOSITS are reported upon by Mr. Wada, ex-chief of the Mining Bureau of Japan. The surveys have so far only extended over one-tenth of the iron-bearing strata of the country, but he estimates that the mines of Iwate would alone produce 30,000,000 tons, with strata of equally productive capacity already located in other parts. He finds the iron equal in quality to that imported, and it makes equally good steel. The substitution of native for foreign iron would mean great economies, as the freight on cast iron now represents 75% of its cost, that on wrought iron is 27%, and that on steel is about 40%. Japan has already imported, in rails, bridges, locomotives and railway supplies, over 430,000 tons of iron and steel, and Mr. Wada estimates that it will require about 17,200 tons annually to relay track already in use. New railways projected will demand a very large amount.

THE MICHIGAN MINING SCHOOL, at Houghton, Mich., is sending out a circular to mining concerns, in which it offers to make for them, free of charge, mechanical tests of materials of construction under certain prescribed conditions. The curriculum of the school includes a course in testing materials, and practical work with the testing machines is to begin on June 15, and continue for five weeks. Samples received by that time, which must be prepared by the sender ready for test, will be tested by the students as part of their regular work, and reports will be forwarded when the course is completed. A set of blue prints, giving full instructions for the preparation of test pieces, accompanies the circular.

THE NEW STEEL FORCE MAIN for the water supply of New Bedford, Mass., will have ordinary joints and riveting instead of butt joints and interior countersunk rivets. Alternative bids for this work were published and commented on in our issue of March 26. The contract for lap-jointed pipe has been awarded to the lowest bidder, the Carroll-Porter Boiler & Tank Co., of Pittsburg, Pa., for $322,023, which is $23,375 less than the bid of the same company for the other class of work. The force main will be of 5-16-in. steel, and will be about eight miles long.

MORE ENGINEER-INSPECTORS ARE WANTED by the New York Department of Public Works. The position pays $3.50 per day at the start, and applicants must pass a Civil Service examination. The next examination is announced for April 22. Any engineer over 21 years of age and a citizen of the United States is eligible. Blanks for applications may be obtained by addressing S. W. Briscoe, Secy. Civil Service Boards, Criminal Court Building, New York city.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the West Pennsylvania line of the Pennsylvania R. R., near Greenport, Pa., April 1. The two rear cars of a passenger train left the track and went down the bank, and the wreck caught fire. Ten persons were injured, some seriously.——A passenger train on the Baltimore & Ohio R. R. ran into a rock which had fallen on the track near Silver Run, Pa., April 3. The engine was derailed and upset, and the engineman and fireman were badly hurt.

A DERAILMENT ON THE RACK RAILWAY up Snowdon Mountain, in Wales, occurred April 6. The line was opened on that day, and as the first train was making its return trip, the engine left the rails and went over the bank, but the men escaped by jumping. The coupling broke and the cars kept on the rails, but ran down the grade until stopped by the brakes. Some persons jumped from the train and were badly hurt. A second train ran into the cars, badly damaging the rear car.

THREE BOILER EXPLOSIONS are reported in press despatches as having taken place on April 1. The first was at the Planters' Oil Mill, at Greenville, Miss., where two boilers burst, killing five men, injuring several others, and causing a damage to property of $30,000. The second was at a saw mill near Milford, O. Two men were killed and three injured. The third was also at a saw mill, eight miles from Dangerfield, Tex., where two men were killed and two injured.

CONCRETE LINING FOR THE BOZEMAN TUNNEL on the Northern Pacific R. R. is to be constructed as a result of the recent disastrous fires in the tunnel, which have burned out the timbering, caused heavy falls of rock, and made it necessary to carry all traffic over the old switchback line. The work will occupy about three years.

A NEW ST. LAWRENCE BRIDGE is proposed by the Brockville & New York Bridge Co., holding a charter from the Dominion of Canada for bridging the St. Lawrence River at Brockville, Ont. This corporation has recently been consolidated with the St. Lawrence Ry. Co., of New York. The capital stock of the combined companies is $2,000,000, and the new board of directors is as follows: Chas. Macdonald, Joseph S. Decker, Wayne Griswold and Clarke R. Greggs, of New York, and Charles J. Purey, W. P. Cole, Daniel W. Downey, G. A. Weatherfield and L. B. Howland, of Brockville. Some masonry work for this bridge was built on the Sister Islands last year, and the rumor is that general construction is to be pushed vigorously the coming season.

THE POUGHKEEPSIE BRIDGE is possibly to have the Eastern outlet of which it was deprived by the failure of the scheme of 1892 to make it a connecting link between the Philadelphia & Reading and the New York & New England and Boston & Maine lines. The bridge property was at that time reorganized as the Philadelphia, Reading & New England Ry. Co., forming, with its leased properties, a line 167 miles long, extending from Campbell Hall, N. Y., to Hartford, Conn. Since the collapse of the Philadelphia & Reading R. R. Co., the bridge company has been in the hands of receivers. It is now proposed to build a line from Tariffville, Conn., to Springfield, Mass., connecting the bridge with the Boston & Albany R. R. The right of way to the Massachusetts line has been secured and paid for and as soon as arrangements can be made with the Reading Company in regard to bond interest guaranteed by that company, it is believed that the connecting line will be built.

A BRIDGE BETWEEN SAN FRANCISCO AND OAKland, Cal., is proposed by Mr. Lyman Bridges. It would be 17,000 ft. long, with two drawspans of 250 ft. each.

A NEW BOARD OF TRUSTEES FOR THE BROOKlyn Bridge is recommended by the Assembly Committee on Cities, of the New York State legislature. The proposed board is to consist of four members (with no ex-officio members) appointed by some representative authority, acting for the interests of both cities. The salary of the treasurer is to be abolished, and the duties of treasurer to be performed by one of the trustees. The salaries of trustees are to be $3,000, and extra sums of $2,000 and $1,000 are to be paid to the trustees who shall be selected as president and treasurer. None of the trustees is to be interested in any firm or corporation contracting with or receiving privileges from the bridge.

THE BROOKLYN SURFACE ROADS meet the proposition of the elevated railways to lease and operate the railway tracks across the Brooklyn bridge (to run through trains) by a counter proposition to the bridge trustees and the mayors of New York and Brooklyn. The six chief surface systems offer to bring about a mutual traffic agreement among themselves and to run their cars over the bridge without extra fare and upon terms at least as favorable to the public as any offered or to be offered by the elevated railways. The petition says that in the last fiscal year these surface lines carried over 150,000,000 passengers out of a total of 206,000,000 carried by the surface and elevated roads of Brooklyn combined. They ask that no legislation be favored which does not expressly provide equal facilities for the surface roads in running cars over the bridge; any such legislation should expressly prohibit discrimination in favor of the patrons of any one system of railways.

INSTRUCTION IN ELECTRIC RAILWAY WORK is to be given to the students of the Pennsylvania College, at State College, Pa., and arrangements have been made for the use of one mile of track of the Bellefonte Central Ry. Wires and poles will be erected, and power supplied by the plant in the engineering building of the college.

VERY LONG STREET-CAR RIDES for a 5-ct. fare are now given by the Nassau Electric Ry. Co., of Brooklyn, N. Y., which has added the lines of the Atlantic Ave. R. R. Co. to its own system. A single fare will now enable a passenger to ride from any of the ferries to Coney Island, Canarsie and several outlying suburban districts, while a very liberal arrangement of transfers has been arranged. The Brooklyn City R. R. carries passengers 15 miles for a 5-ct. fare on some of its routes, but it is said this will be exceeded by the Nassau company's lines.

STREET MAINTENANCE AT EAST ORANGE, N. J., is to be carried out on a more systematic plan than heretofore, largely as a result of a paper read by Mr. W. S. Bacot, M. Am. Soc. C. E., before the Township Improvement Association. An abstract of the paper was published in our issue of Feb. 6. The township committee has now recommended an increase in the annual appropriation for street maintenance from $15,000 to $25,000, together with a special fund of $5,000 for purchase of implements, etc.

THE NATIONAL HIGHWAY COMMISSION BILL has been favorably reported upon by the House Committee on Agriculture. The commission is to consist of the Chief of Engineers of the Army, the Director of the Geological Survey, and the Chief of the Road Enquiry Bureau of the Department of Agriculture. The objects of the commission were discussed in our issue of Jan. 30.

THE HAWAIIAN CABLE SCHEMES, now before the Senate Committee on Foreign Relations, have practically failed as a result of rivalry between the New York, or Scrymser, and the New Jersey, or Spaulding, companies. A bill has been agreed upon in the committee, as containing the best features of the two propositions submitted, and each company was ready to accept the bill as framed. But when it came to inserting the name of the company in this bill it was found that each had gained supporters among the Senators, and the result of several ballots was a failure to agree to report the bill. It is now suggested that the rival companies pool their interests.

A REPORT ON THE TYPHOID EPIDEMIC AT ELmira, N. Y., has been made by Prof. Olin H. Landreth, of Schenectady. After a careful study of local conditions and of bacterial and chemical reports by various persons, Prof. Landreth concludes that the epidemic was started through the public water supply, which was probably infected by sewage discharged into the Chemung River; that water from the filter gallery is liable to infection through ground water contaminated by privy vault and cesspool matter; that there have been a number of secondary cases caused by the contamination of private wells from privy vaults and cesspools; that the water from private wells is now more dangerous than that from the public supply. Only a part of the water supply is from the filter gallery, much of it being drawn from the Chemung River and some coming from impounding reservoirs. About 48% of the population regularly uses the public supply, and probably not more than 55% use it at all, the report states. The total number of cases of typhoid fever and the percentage of these using the public water supply for the year 1895, for January, February and the first 14 days of March, 1896, was as follows:

	Typhoid cases.	% using public water supply.
Year 1895	107	65
January, 1896	109	93
February, 1896	137	90
14 days in March	34	70

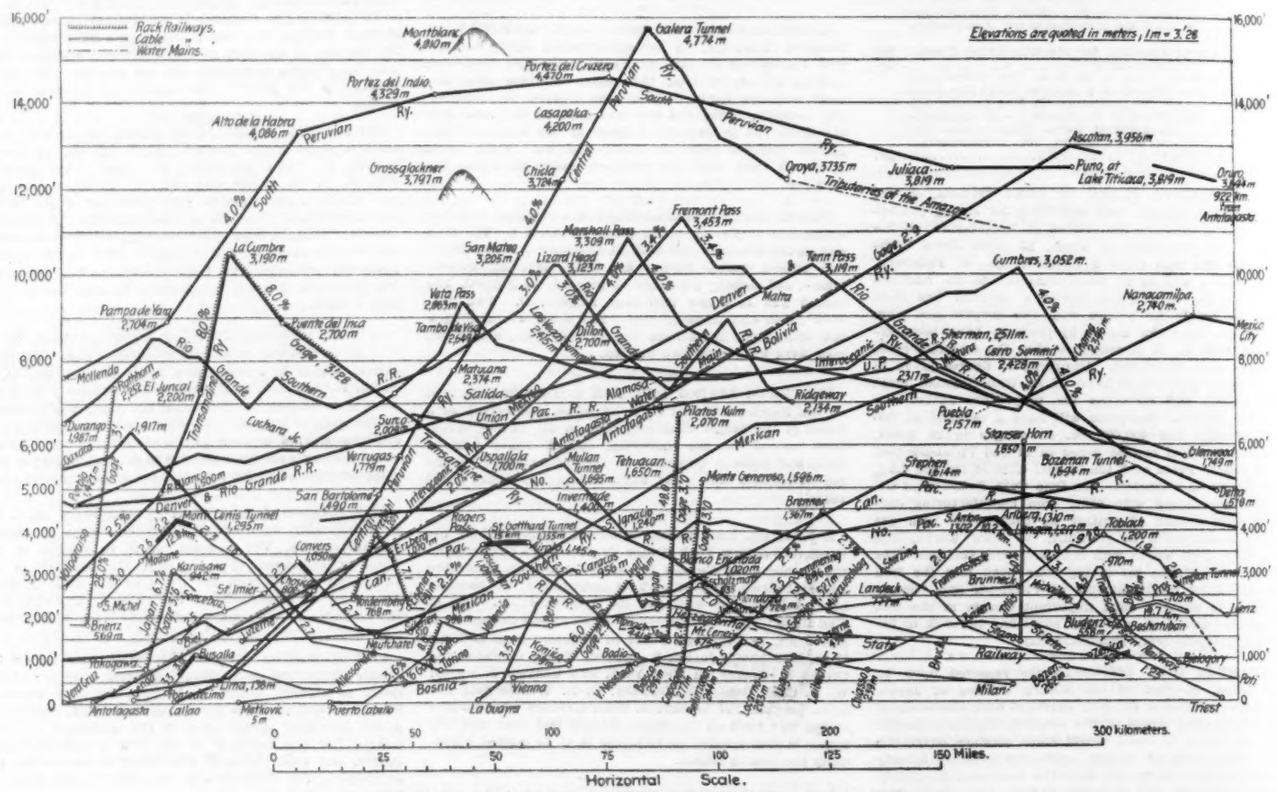
PROFILES OF THE PRINCIPAL MOUNTAIN RAILWAYS OF THE WORLD.

Some years ago Mr. W. W. Evans prepared an interesting diagram of the profiles of a number of the principal steep grade and mountain railways of the world, to show their relations to the grades and summit elevations of the Peruvian railways. To this diagram the late A. M. Wellington added the profiles of the Pennsylvania R. R., the Baltimore & Ohio R. R., the Denver & Rio Grande R. R., and the line which he surveyed from Vera Cruz to the City of Mexico, via Jalapa (which line has since been practically followed by the Interoceanic Ry., which now competes with the older line of the Mexican Ry. between these two points). This combination set of profiles accompanied Mr. Wellington's paper on "The American Line from Vera Cruz to the City of Mexico, via Jalapa," in the Transactions of the American Society of Civil Engineers, September, 1887, and was published in Engineerng News, Sept. 3, 1887, and in Mr. Wellington's well-known treatise on "The Economic Theory of Railway Location." In a recent number of the "Zeitschrift der Oesterreischen Ingenieur und Architekten Vereines," we find this same diagram, somewhat modified, and brought more nearly up to date, but no credit is given to, or any mention made of, the earlier publications on which the diagram is based. Nevertheless this later diagram is of some special interest in that it shows a number of recently built mountain lines, and we have therefore redrawn it and present it herewith, with the above explanation as to its history. We have shown the railways on the continent of North and South America by heavier lines than those of the railways in other parts of the world.

The journal above mentioned states that the greatest altitude reached by any standard gage railway in Europe is 4,483.7 ft., at the Brenner Pass, over the Alps; the Peruvian Central Ry., on the other hand, crosses the Andes, through the Galera tunnel, at an elevation of 15,658.72 ft. above the sea. This South American tunnel lies at an elevation nearly equal to that of the summit of Mont Blanc; and while the snow line on the Andes lies still higher, varying from 15,745 to 17,000 ft. above the sea, the conditions are such as to render railway construction extremely difficult.

The standard gage railway connecting Callao and Oroya, the most prominent on the diagram, has a total length of 142.6 miles, and ascends the mountain with a 4% grade 99 miles long. The longest narrow gage railway shown is the Antofagasta & Bolivia Ry. to Oruro, 571.6 miles long. While the "Zeitschrift" admits that the highest railways are to be found on the American continents, it consoles itself with the assertion that in length of railway tunnels, at Mt. Cenis, St. Gotthard, the Arlberg and in the projected Simplon tunnel, Europe is still ahead of the rest of the world.

In this diagram rack and cable railways are indicated by proper distinguishing symbols; and in this connection, it may be noted that the scale used makes a 60% grade appear very nearly vertical. The water-main shown parallel to the Antofagasta Ry. is 173.6 miles long, and it supplies the city of Antofagasta and the stations along the line of the railway.



PROFILES OF THE PRINCIPAL MOUNTAIN RAILWAYS OF THE WORLD.

THE ART OF FIREPROOFING.

I.

By Herman B Seely, Contracting Engineer for Fireproofing.

(With inset.)

The art of fireproofing treats of methods of constructing buildings so that the building frame shall resist the attack of heat due to the combustion of its contents and finish. The frame may be formed of combustible or incombustible materials, but the purpose of this article is to illustrate the principles pertaining to the fireproofing of incombustible building frames.

The object of fireproofing is economic, and the preservation of the frame from the destructive effects of fire must be attained with the least initial outlay and least cost of repairs after a fire. Where scientifically applied, the means employed are proportioned to the severity of the fire that reasonably may be expected from the nature and uses of the building itself and those of buildings adjoining. While the employment of constructive materials is dictated oftentimes by considerations other than resistance to fire, the broad, general principles of their combination are best illustrated by chimney stacks and kilns intended to be continually subjected to high heat. These structures consist of a frame and lining. The lining receives the attack of heat and expands, contracts and is damaged. It is therefore constructed so as to develop these effects with the least amount of damage, and that without disturbing the frame.

The basic material of modern building frames is steel. A more or less complete skeleton of this material is erected to be covered with finishing material and filled in with some style of floor construction. An examination of the properties of steel when subjected to heat is a prerequisite, therefore, to a clear understanding of the requirements for its successful fireproofing.

Properties of Steel Framing Members When Heated.—When steel is heated to 572° F. it loses 10% of its strength, and when heated to 752° F. it loses 50% of its strength. Assuming 70° F. as the normal temperature the coefficient of expansion of steel at 600° F. is 0.00335, and at 300° F. is 0.00146. For cast iron the coefficient of expansion at 600° F. is 0.00326.

Steel in construction may be subjected to even heating or to uneven heating. By even heating is meant such an application of heat to a steel member that all parts shall have the same temperature at the same time. The expansions of a 20-ft. steel beam at 600° F. and 300° F. are 0.8 ins., and 0.34 ins., respectively. The expansion of a 12-ft. steel column at 600° F. is 0.48 in., and of a 12-ft. cast-iron column at 500° F. is 0.47 ins. From the foregoing it may be deduced that 300° F. is the allowable limit of temperature for beams, owing to excessive expansion at a higher range, and 600° F. the limit for columns, owing to excessive loss of strength beyond that degree.

By uneven heating is meant such an application of heat to a steel member that different parts have different temperatures at the same

time. Let Fig. 1 represent a beam 20 ft. long, so heated that the bottom flange is about 100° F. hotter than the top flange. The bottom flange is thereby elongated 3-16 in. more than the top

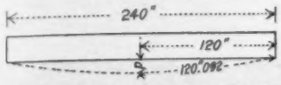


Fig. 1.—Diagram Showing Effect of Heating 24-ft. Steel Beam 100° F. Hotter on Bottom Than on Top Flange.

flange. The beam in use in a building would tend toward the position shown by the dotted line and the deflection d would be approximately 4½ ins.

$$d = \sqrt{120.092^2 - 120} = \sqrt{22} = 4.7 \text{ ins.}$$

Uneven heating is therefore a condition which cannot be allowed, as slight differences of temperature produce bends and twists involving disastrous damages if not complete destruction. This effect of uneven heating is apparent at the cooling tables, where beams are placed after leaving the rolls. They must be constantly watched and turned to correct deviations produced by slight air currents.

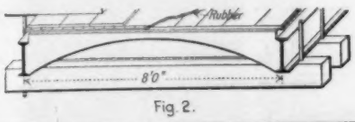


Fig. 2.

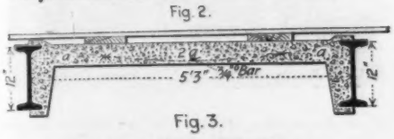


Fig. 3.

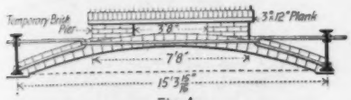


Fig. 4.

Fig. 5.

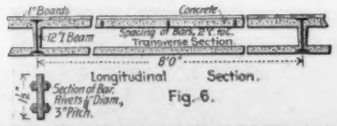


Fig. 6.

Fig. 10.

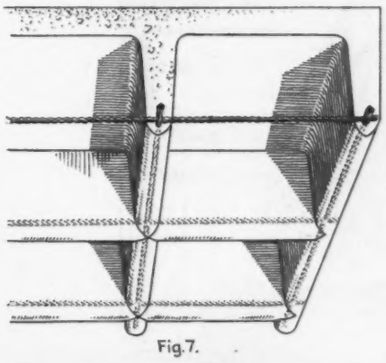
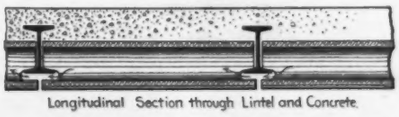
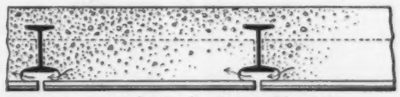


Fig. 7.



Longitudinal Section through Lintel and Concrete.



Longitudinal Section through Concrete.

Transverse Section through Lintel and Concrete Filling.

Fig. 8.

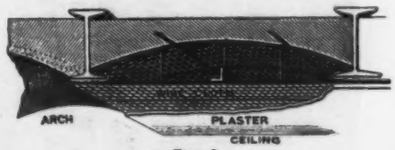


Fig. 9.

FIGS. 2 TO 10.—FORMS OF FIREPROOF CONSTRUCTION IN COMMON USE.

Bearing in mind the broad principles illustrated by kilns and stacks in the above properties of metallic framing members when heated, the following rules for the scientific construction of incombustible buildings result:

(1) All surfaces exposed to the direct attack of heat must be devised so as to expand, contract and be repaired without disturbing the metallic frame or the floor construction.

(2) The surface must stay in place and outlast the fire and water thrown to extinguish it, and must prevent the transmission of heat to an extent sufficient to damage the frame or floor construction. The limits of allowable temperature under this rule are 300° F. for beams and 600° F. for columns.

Fire records have shown that only two devices meet the requirements of the above rules—first, common brick, and second, wire cloth and plaster. Both outlast fire and water, and wire cloth and plaster can be applied independent of the frame and in any position.

The methods of applying surface material so as to maintain the limitation of temperature above stated, are little understood, and careful experimenting is needed to establish satisfactory data. This will be explained more at length in another portion of this article. It may be stated here, however, that efficiency depends primarily on thickness of materials, and secondarily on diffusion of transmitted heat by connected air spaces.

As a preliminary to the discussion of methods of proportioning protective coverings to standard requirements, it is necessary to classify the floor constructions in use and arrive at their value as far as disclosed by fire records. It will be noticed that very few constructions observe the rules that have been stated above; and that while there are classes of buildings where their non-observance is a matter of no importance, there are others that thereby develop disastrous damages.

Incombustible buildings may be classified as follows: (1) Those without metal constituents; (2) those with metal constituents exposed; (3) those with metal constituents protected by materials of construction; (4) those with metal constituents protected by materials of finish. Buildings without metal constituents are monumental in character, and of comparatively rare occurrence, and need not be considered at length in this article.

Buildings with Metal Constituents Exposed.—Fig. 2 represents a common construction used in buildings of this class. It consists of an arch of brick, tile, concrete or corrugated iron and concrete abutting upon steel floor beams. The composition of the arch is of little importance, as the massing of the material at the beam with exposure of the bottom flange alone facilitates the condition of uneven heating. It was calculated that a sharp increase of temperature of 100° F. in the bottom flange would suffice to disrupt this construction by deflection of the beam. This calculation is verified by European fire records, and in Germany firemen are not allowed to enter such buildings while a fire is in progress. The arches fall when there is no visible evidence of fire. Nevertheless this construction is quite prevalent, and its cheapness has introduced it into warehouses in positions where it is the most dangerous of all constructions in fire.

Buildings with Metal Constituents Protected.—Figs. 3 to 10 are taken from the advertisements of floor constructions used in these buildings. Figs. 3 to 8 form Class 3, affording protection with materials of construction, and Figs. 9 and 10 form Class 4, affording protection with the materials of finish. It is of interest to note wherein these constructions differ from the admittedly dangerous type, Fig. 2. Figs. 3 to 7 use a thin plate of the constructive material under the bottom flange of the beam. Remove this plate and Fig. 2 appears. Fig. 8 in addition to the thin plate of tile claims a connected air space equivalent to a uniform layer 1⅛ ins. thick, with ventilating outlets at the walls. Fig. 9 is typical of various constructions, and comprises every variety of the type of Fig. 2, with a suspended ceiling added, affording an air space equivalent to a uniform layer about 4 ins. thick, and which may readily be connected throughout the entire floor area. Fig. 10 differs from all the foregoing in having no material between the beams, and affording an interconnected air jacket equal in thickness to the depth of the beams. All the constructions, except those affording ventilation, transmit heat to the bottom flange of the beam first. Leaving the air space out of account, the protection afforded to the beam by all these systems is the least amount of material that the exigencies of their erection will admit.

The attachment of protective coverings other than suspended ceilings is the adhesion of the material or the mortar of its joints to the beams. In the case of hollow tile, the prevailing construction, the protection is about ⅝ in. thick, and often drops off during the erection of the building. As this is a very poor protection, and has been erected long enough to have incurred several fires, its record serves as a useful basis for determining the value of fireproofing in general and the probable value of construction other than tile.

Fire Records.—Fig. 11 shows the effect of heat in an unprotected iron frame, and is introduced here as of interest on account of the large amount of damages from an insignificant source. One cold night some scaffolding beneath an ornamental steel and glass roof at the bottom of a court in the Marquette Building, Chicago, took fire. The blaze was a small one, and so far as strength was concerned, the roof was not damaged. The buckling and twisting, however, caused by the flames striking the heavy and very cold steel frame produced a total loss of the roof in a very brief interval and with the combustion of very little fuel. This fire is instructive as to the hazards of exposed steel roofs. The loss was $2,600.

Schiller Building, Chicago.—The Schiller Building has a court on the side, and the court wall is composed of an iron frame protected by 6-in. vitrified tile blocks. A fire broke out in an adjoining building of combustile construction so that the source of flame was about 30 ft. distant from the tile wall. Air currents threw the flames against the tile, with the result that the outer faces fell off and a portion of the iron frame was completely exposed. Flames entered the building and destroyed the finish in several offices. This was not a severe attack. Common brick walls adjoining the tile walls were uninjured, although the wood frames of the windows were burned out like those in the court wall. Cast-iron columns in the combustible building in the center of the hottest part of the fire, entirely unprotected, were uninjured (Fig. 13). The manner in which the tile faces came off may be seen in Fig. 12. Had the source of heat been closer to the court wall or had the flames been thrown with greater force against it, the columns would have been wrecked, destroying a portion, if not all of the building.

Temple Court Building, New York.—This fire was caused by combustion of office material and wood finish. It was not a severe attack, as may be seen by the partly consumed papers and fin-

ish. The points to be noticed, Figs. 14 and 15, are the fractured tile faces, and the complete loss of plaster, both on tile and brick walls. The small amount of heat required to remove plaster from walls may be seen in Fig. 14, where combustion was very incomplete. Note also the destruction of the tile partitions.*

Athletc Club Building, Chicago.—This fire occurred as the building was nearly completed. The gymnasium on the fourth floor, two stories in height, had paneled oak wainscoting on the entire walls and ceiling, and there was considerable finish designed for other rooms stored there temporarily. This took fire and with the paneled oak work was completely consumed. The heat generated escaped by windows and doors and up stairway openings, and, entering the upper rooms, consumed to a greater or less degree the door and window frames and finish. One room, the large dining hall, had considerable scaffolding in place for use of the plasterers. The plaster was destroyed by fire above the fourth floor and by water below that point. The same could be said of the wood finish. The building had an iron interior frame with porous terra cotta arches and coverings. Figs. 16, 17 and 18 are photographs of this fire and show the destruction of plaster and partitions in rooms where there was no combustible material to speak of, and even that but partially consumed.

Photographs showing the condition of the tile in the gymnasium, the only room which may be said to have incurred an attack of fire, are not obtainable. The photographs shown, and some others, were taken to illustrate an article on the fire published in the "Engineering Magazine" of February, 1893. It is a pity that no illustration of the gymnasium was given, but that would perhaps have interfered with the opinion of the writer of the article, viz., that porous tile will stand fire and water. As a matter of fact, so far as insurance was concerned, the entire construction exposed to fire was destroyed. Beams were twisted and arches damaged in a manner similar to that shown in Fig. 16 to such an extent that the cost of properly replacing the construction in its original condition was estimated to be several times its initial value. I am able to furnish an adjuster's estimate to parallel with the statement of the writer of the article mentioned, which was as follows:

> Here, however, the damage ceased. In its structural entirety the Athletic Club Building remained apparently intact. The tile arches of porous terra cotta are practically uninjured by the combined action of intense heat and tons of cold water; not one arch has fallen, and recent tests made on the worst looking arches developed a sustaining capacity of 450 lbs. per sq. ft. without sign of rupture. The partitions, also of the same material, were practically intact and as originally built, except that every door, door frame and casing, and all base, wainscoting, and woodwork of all descriptions entirely disappeared, and the plastering was completely stripped off, leaving the tile bare. The wood floors were entirely consumed, and in many places the strips bedded in the concrete to receive the floor were burned completely through.

The following is the adjuster's estimate of the damage:

Heating and ventilation	$7,745.00
Engine	50.00
Mosaic floors	500.00
Hardware	1,307.00
Elevators	2,350.00
Water filter	50.00
Steel columns, beams and girders	8,286.00
Outside window frames, sashes and stone sills	5,316.48
Grounds and rough frames for inside partitions	4,260.00
Floor strips	2,130.00
Shoring up floor beams and scaffolding to take down front	4,047.00
Temporary stairs	213.00
Plastering	17,500.00
Gymnasium fixtures	500.00
Inclose building and cleaning up debris	3,453.65
Tile arches	10,441.92
Tile partitions	3,173.82
Fireproofing steel columns	806.20
Tile furring outside walls	454.84
Concreting floors	1,516.77
Repairing tile partitions and beam covering	532.50
Skylights, copper gutters and conductor pipes	5,850.00
Taking down front (cut stone and brick work) and replacing same	41,485.00
Tile floors	414.00
Pipe and wire for electric valves	1,400.00
Repairing rear wall and rebuilding walls of the north and south courts	4,254.57
Carpenter work	51,900.00
Wiring for electric light	7,500.00
Marble work	7,600.00
Plumbing	6,000.00
	$201,137.91

*Illustrations and descriptions of the Temple Court fire were given in Engineering News of April 13, 1893.

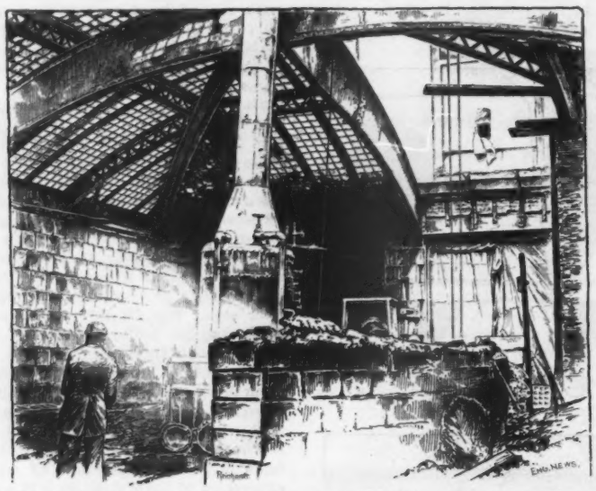


FIG. 11.—SHOWING EFFECT OF SMALL SCAFFOLDING FIRE ON IRON AND GLASS ROOF, MARQUETTE BUILDING, CHICAGO.

Fig. 12.—Destruction of Tile Wall of Schiller Building, Chicago, by Fire 30 ft. Away.

This fire clearly illustrates the extent of loss caused by replacing structural damages that are virtually finish damages. The very expensive carved stone front was ruined by what were mostly skin deep damages, and the cost of taking out and replacing to arrive at the original degree of finish was in excess of the total original value.

The estimated cost of restoring the original status of beams, tile and concreting for a building in which one floor only may be said to have been attacked by a severe fire was $25,000—a complete illustration of the result of using a constructive filling as fireproofing. In repairing the building most of the bent beams were accepted as good enough, and a new construction installed where the tile arches had been damaged. These were accepted as good enough for floor support, and a ceiling of expanded metal was attached to the beams and damaged tile.

FIG. 13.—VIEW OF SITE OF FIRE CAUSING DAMAGE TO SCHILLER BUILDING 30 FT. AWAY.

If a ceiling of expanded metal is good enough as a fireproofing device, and durable enough as a structural device, to be installed after a fire in so important a building as the Athletic Club, its original installation would have been proper and would have saved insurance companies a very considerable loss. There is therefore a

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Fig. 14.

Fig. 15.

FIGS. 14 AND 15. PLASTER AND PARTITION DAMAGES, FIRE IN TEMPLE COURT BUILDING, NEW YORK CITY.

Fig. 17.

Fig. 18.

FIGS. 17 AND 18. PLASTER AND PARTITION DAMAGES, ATHLETIC CLUB BUILDING, CHICAGO.

THE EFFECT OF FIRES IN FIREPROOF BUILDINGS.

(Accompanying Paper by Herman B. Seeley, Chicago, Ill.)

marked distinction capable of being expressed in rates between those constructions that resist fire structurally and those that resist with detachable finishes.

The plaster used was a patent article, showing that in combination with tile it is no better than common plaster. The fire in the gymnasium affords a sufficient test of the adequacy of strips and concrete coupled with water and debris to protect beams from fire above them. There seems to be no need of further protection in this direction.

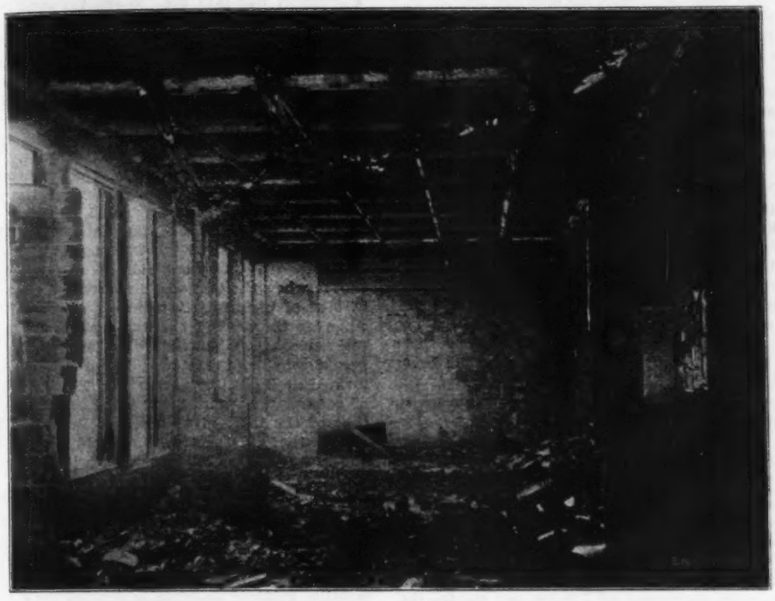

FIG. 16.—PLASTER AND PARTITION DAMAGES TO ATHLETIC CLUB BUILDING, CHICAGO.

It will be noticed that those cuts, in which ruined tile partitions are shown, exhibit no evidence of a considerable amount of tile debris on the floor. This may be due to a fact noted by firemen that hot tile partitions appear to dissolve or fly into powder as water strikes them. The Schiller Building wall was hard tile, and the Athletic Club partitions porous tile, so that there is no practical difference in the two varieties. The Temple Court fire is a fair example of the maximum internal fire to be expected in office buildings, hotels, public buildings, etc., in which office material and finish furnish the fuel. The tile construction is sufficient for protection in these cases, and so, evidently, is any construction that covers the metal frame, for none so far produced have a beam protection so thin and easily removed as that of tile.

The formation of exposure walls with steel and tile is a dangerous practice and should be abandoned. A brick covering weighs but little more, is better structurally, and will not disappear at the first onset of flame. The Schiller Building fire gave ample notice of danger, but this has not prevented the subsequent erection of several very tall buildings with tile walls exposed to the worst possible hazards. The Athletic Club fire, with beams and columns stripped of coverings and in places distorted by heat, approaches the test to be expected in a mercantile building. Some amazement has been expressed that the interior frame stood at all under the conditions present in the gymnasium. This was due in part to fortuitous circumstances, such as preserved the unprotected cast-iron columns in the building adjoining the Schiller Theater (Fig. 13), and also to the fact that the paneled oak finish which served as fuel at the same time covered and effectively protected the tile until consumed. At this stage the firemen were in evidence and the fire under control. This fire indicates the complete failure of tile in severe tests. Mercantile buildings and large area stores under offices demand better protection than tile. It cannot be used at all in these positions without being itself protected.

Another practice, and a growing one, should be watched with the utmost care—i. e., the carrying of tiers of offices over theaters or large assembly rooms. The trusses in most of these cases have but flimsy protection, and their need of a better protection may be read in the Marquette Building's loss of $2,600 from a bonfire. The total wreck of tile partitions in many fires suggests the query: Why build them? They contain a large percentage of unprotected wood framing, are no barrier to flame and are a source of annoyance and expense from the day of their erection.

The stud partition with wire on both sides is a more convenient device, less productive of repairs, and stands fire very much better. If the studs were spaced 3 ft. apart and covered with wire and plaster at the openings, the additional amount of wood over that contained by tile partitions would be insignificant and the covering of the rough framework of openings would insure a smaller percentage of loss.

The partitions of plaster of paris tile are much superior in resistance to fire to those of clay, but possess a large share of their structural disadvantages.

Constructions Other than Tile.—For all buildings in which tile suffices, these constructions are of interest only as to their cost and structural qualities. Where tile fails the question arises, in what respect are they any better? Those varieties which shield by materials of construction are evidently no better, since we have no constructive materials which do not expand too much or disintegrate when subjected to great heat. Concrete, for instance, has the same coefficient of expansion as steel, and necessarily the same safe limits of temperature. It is also akin to stone, and disintegrates in like manner when struck by intense heat. The constructions with detachable ceilings are an improvement, since the inevitable ceiling damage can be repaired without disturbing the floor above. The cost of taking out a concrete or tile construction to repair a damaged ceiling which is an integral part of a floor above possibly undamaged is many times the initial cost of the disturbed area.

The fireproofing value of detachable ceilings may be estimated from a fire in one of Mr. Potter's buildings. The ceiling was attached to wooden beams by special devices and was back plastered. This fire is noted in the treatise on Constructions, issued by Mr. E. C. Moore, as follows:

> One of Mr. Potter's buildings constructed on this plan was subjected to a thorough test in the case of a fire which burned all night in the basement and with such intensity as to almost destroy solid brick piers without piercing the floor above.

Here evidently is an inexpensive device capable of meeting all requirements. Its efficacy in the above case was due to the back plastering, which retarded the transmission of heat, and also to the pervious nature of the construction above the ceiling, which diffused the transmitted heat and permitted it to escape.

Had the ceiling been composed of wire and the usual coats of plaster, the loss of the finishing coat, and possibly the second coat, would have allowed a great deal of heat to reach the frame above. If the heat had accumulated, the ignition point of the beams would have been reached at an early stage of the fire.

Many instances may be found that establish beyond a doubt the ability of wire cloth and plaster to outlast a fire. The value of the different metallic laths in combination with the different plasters and the thicknesses required for the various positions in which protective coverings are used will be discussed in the succeeding portion of this article.

SLAG CEMENT IN GERMANY.

U. S. Consul-General Frank H. Mason, of Frankfort, Germany, sends to the Department of State a report upon the slag-cement industry of Germany, of which the following is an abstract:

Slag cement seems to have been originally suggested by the excellent results obtained in Italy by a mixture of hydraulic lime and puzzolani, or pulverized volcanic lava. About 1863 the proprietors of the George Marie blast furnace, in Westphalia, produced a slag cement and described the process, and other furnacemen soon recognized the possibility of thus disposing of the hitherto worthless slag.

Various methods have been patented for granulating and preparing the slag, among them that of Ludwig Roth, of Wetzlor. It was soon found, however, that the chief difficulty lay in the constituents of the slag itself. The essential cement-making element in the basic slag is silicic acid, and the questions to be determined were whether this acid was in sufficient proportion; whether it was in condition to readily and firmly unite with the lime, and whether there was a due proportion of magnesia and no excess of sulphide of calcium or sulphuric impurities. Through these practical difficulties German cement makers stumbled for years, until finally repeated failures brought the whole process into disrepute, and the Portland cement makers, to defend themselves against the charge of adulteration with cheaper slag cement were compelled to sign an agreement to make no more of it. To-day, says Mr. Mason, only two firms in Germany manufacture slag cement, Messrs. Bocking & Dietsch, of Malstatt-on-Saar, and Erhardt Bros. and Lingenbrinck, of Neunkirchen; both are firms of large resources and of the highest responsibility.

These firms maintain fully equipped testing establishments, and the product is approved of and used by the engineers of Frankfort, Cologne and other German cities. In shipments of 50 tons or more, it is sold at $1.28 per barrel of 330 lbs. As compared with Portland cement, it has a lower specific gravity, and ten metric tons of slag cement occupy 10 cu. m. of space, while the same weight of Portland cement fill only 7 cu. m. Slag cement is generally used in the proportion of 1 part of cement to 3 or 4 parts of sand, and requires about 24 hours to set.

This slag cement is successfully employed in building foundations and in hydraulic construction, but it is not adapted to boiler setting or to use in the open air as mortar for brickwork. It is used in the foundations of sewers, but owing to its slow setting is not employed in the upper parts of such construction. It is also extensively used in the manufacture of paving tiles, being for this purpose mixed with fine Rhine gravel and quartz sand and submitted to a pressure of 500 tons in a hydraulic press. The resultant tiles, eleven of them covering 10.8 sq. ft., or 1 sq. meter, cost 81 cts. per sq. meter. Slag from gray foundry pig, smelted under high pressure and as free as possible from sulphur, is generally selected for this purpose. A slag giving good results is thus analyzed by Roth in 1883: Lime, 51.62%; silicic acid, 35.12%; argillaceous earth, 8.53%; magnesia, 1.58%; peroxide of iron, 0.87%; per-

oxide of manganese, 0.37%; sulphur, 0.88%. Those interested further in this industry are referred, by Mr. Mason, to the writings of Prof. Tetmaier, of Zurich, one of the greatest living authorities upon building materials and an early advocate of slag cement.

Consul P. Lieber, of Dusseldorf, says there are five concerns making slag cement out of the 20 active German cement factories, but Dr. Wilhelm Michaelis, of Berlin, an authority upon cements, says that the industry is well-nigh suppressed and dead in Germany. Dr. Michaelis ascribes this to the fact that the government has been ill advised and has failed to give the cement a proper trial, and then the well organized and powerful Portland cement industry "formed a ring against slag cement." He says the manufacture is well developed in France by a premium on excellence offered by the government.

THE AUSTRIAN TESTS OF ARCHES.

By Mansfield Merriman,* M. Am. Soc. C. E.

In 1890 the Austrian Society of Engineers and Architects appointed a committee to undertake a comprehensive series of experiments on arches used in buildings and for bridges. The committee consisted of 21 members, Ernst Gaertner, chairman, and Alfred Greil, secretary, the actual work being, however, done by a sub-committee of 13. The report of this committee, recently issued, is a document of 131 folio pages with 27 plates.** It is without doubt the most valuable contribution to the theory and practice of arch construction that has ever been made, as the tests were carefully planned, executed on a large scale, and discussed by most competent authorities. The cost of the experiments was 21,250 florins (nearly $10,600).

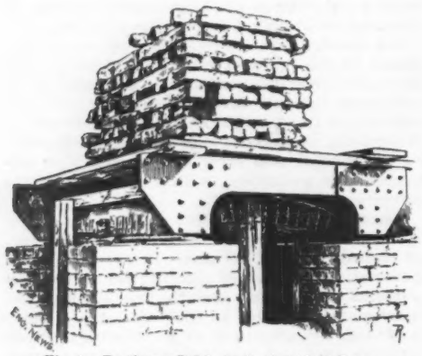

Fig. 1.—Testing a Brick Arch of 4.43 ft. Span.

The work done by the committee is presented in seven chapters of the report, and of each of these a brief synopsis will be given.

I. Tests of Floor Arches.

Seventeen arches, having spans of 4.43 ft. and 8.86 ft., were tested to destruction by a uniform load. Of these four were common brick arches, five were of special forms of brick, three were concrete arches, three were Monier arches, one was of the Melan system, and two of corrugated plates. Most of these were built between rolled beams in the manner usual in floor construction, these beams being prevented from spreading by plates and channels at the ends, and also by a tie-rod at the middle. The space above the arch and between the beams was levelled up with earth, upon which a board floor was laid, and upon this pig-iron was piled as seen in Fig. 1.

The tests were made four months after the arches had been built. All these arches were designed for an allowable load of 123 lbs. per sq. ft. of load, besides their own weight, and were expected to rupture with about eight times this load, or, say, 1,000 lbs. per sq. ft.

Seven floor arches, with spans of 4.43 ft., were tested in this manner. Under a load of 1,000 lbs. per sq. ft., none showed cracks or signs of failure. Under 1,500 lbs. per sq. ft. the tests of two arches were discontinued on account of a deformation of the beams and their connections, although the arches themselves were intact. On the other arches the load was increased to about 1,650 lbs. per sq. ft., under which two failed and three remained unbroken. In each case the deflection of the crown of the arch was observed for different loads; under 1,430 lbs. per sq. ft., for example, this deflection varied between 0.39 and 0.98 ins., while for the two arches that failed the ultimate deflections were 1.0 and 1.65 ins.

The conclusions drawn from the tests of these small floor arches are as follows: (1) that common brick arches 4.43 ft. in span, with a rise of 0.44 ft. and laid with lime mortar, show such slight deformations under a uniform load of 1,430 lbs. per sq. ft., that they afford ample security for all common buildings; (2) that ring courses in brick arches are preferable to longitudinal courses; (3) that beton arches 3 ins. thick made of 1 part of Portland cement and 5 parts of sand, have about the same strength as brick arches 6 ins. thick; (4) that flat arches give a much higher strength than expected (although the thrust upon the floor beams is of course greater), and under careful construction they are of ample strength for all architectural purposes.

A second series of tests on arches of 8.86 ft. span was conducted in a similar manner, except that the extra uniform load was applied only over one-half the span. The following table gives the principal data regarding these arches, as also the load causing rupture:

Kind of arch.	Rise, ins.	Thickness, ins.	Dead load, lbs.	Applied load, lbs.,sq.ft.
Concrete	9.1	3.5	4,430	1,128
Monier, 1	10.2	2.0	3,810	1,218
Monier, 2	10.2	2.2	5,410	1,320
Brick, 1	9.8	5.5	4,170	885
Brick, 2	5.3	3.9	3,010	492
Corrugated Plate, 1	9.8	....	2,970	974
Corrugated Plate, 2	10.2	....	2,130	1,100

The loads in all cases were applied gradually and at each increment of 200 lbs. per sq. ft., the vertical and horizontal displacement of the crown of the arch was measured. The concrete arch fulfilled all expectations, and its deformation was less than one-half of that for the brick arch. Of the two Monier arches, the first was built between rolled beams, while the second had solid concrete abutments, the effect of which was to greatly increase its strength. The first brick arch was of common bricks, and the second of a patent brick of much less thickness; the test thus shows that brick less in thickness than the common kinds should not be employed. The first corrugated-plate arch simply butted against the floor beams, while the second was provided at the ends with angle irons; the deflections of these were greater than in any other arch except the brick ones.

A third series of tests on concrete and brick arches of 13.3 ft. span was also undertaken, the abutments being made as nearly immovable as possible. A brick arch of 13.9 ins. rise and 5.5 ins. thickness was loaded over half the span. Under a load of 205 lbs. per sq. ft. the vertical deflection at the crown was 0.29 ins., and the horizontal movement was 0.11 ins. When the load reached 205 lbs. per sq. ft., a small crack appeared on the unloaded extrados, and when it reached 275 lbs. per sq. ft. rupture occurred. A concrete arch, on the other hand, cracked at 410 lbs. per sq. ft., and ruptured at 663 lbs. per sq. ft. A Monier arch, which is of beton built on an arched network of heavy wire or light round iron, cracked at 512 and ruptured at 894 lbs. per sq. ft.

The Melan system, in which the beton or concrete is included, between arched I beams, as shown in Fig. 2, was also tested, the span being 4 meters, or 13.1 ft., the rise 0.94 ft., the I beams one meter apart, and the thickness 3.15 ins. This arch was loaded on one side up to 1,410 lbs. per sq. ft., when the test was discontinued on account of lack of pig iron. Afterwards an area of 1 m. sq. over the second rib was loaded up to 3,360 lbs. per sq. ft., when failure occurred in the manner shown in the figure, large cracks having formed at 3,100 lbs. per sq. ft. This test shows, of course, the strength of the I rib rather than that of the total structure, yet there can be no doubt that this system is a highly efficient one, not only for floors but for small bridges.

II. Tests of Large Arches.

This chapter first gives an account of the test of a concrete bridge arch of the Monier system, 10 m. (32.8 ft.) in span, 1 m. rise, 4 m. (13.92 ft.) wide, and 7.87 ins. in thickness at the crown. The metallic gridiron arching, which lay near the intrados, consisted of pieces 0.39 ins. and 0.27 ins. thick, the former running lengthwise and the latter crosswise, the intervals between them being 21 ins. The space above the arch was levelled with concrete and carried a standard gage railway track. The deflection due to locomotives on one-half of the bridge was first ascertained. Then a uniform load of rails was piled upon one half the span and the deflections determined for successive increments. When the load reached 920 lbs. per sq. ft., cracks appearing near the springing line on the loaded side, and complete failure occurred under a

FIG. 2.—MELAN ARCH OF 13.1 FT. SPAN AFTER TESTING.

*Professor of Civil Engineering, Lehigh University, South Bethlehem, Pa.

**Bericht des Gewolbe-Ausschusses des Oesterreichen Ingenieur und Architekten-Vereins. Vienna, 1895. See also Eng. News, Nov. 21, 1895, p. 351.

load of 2,010 lbs. per sq. ft., the abutment having yielded. A common concrete arch of the same dimensions was then built, and six months later was tested in a similar manner. No failure occurred under a load of 2,110 lbs. per sq. ft. over half the span, although the deflection was over 11 ins. The rupture of the Monier arch under a smaller load is attributed to the fact that the abutments were insufficient in strength.

Five other arches, each 75.4 ft. clear span, 15.1 ft. clear rise and 6.56 ft. width, were especially constructed for the purpose of experimentation, and were tested to destruction. The load was applied at six points over half the span, as shown in Fig. 3. The thickness of each arch, and the rupturing load are as follows:

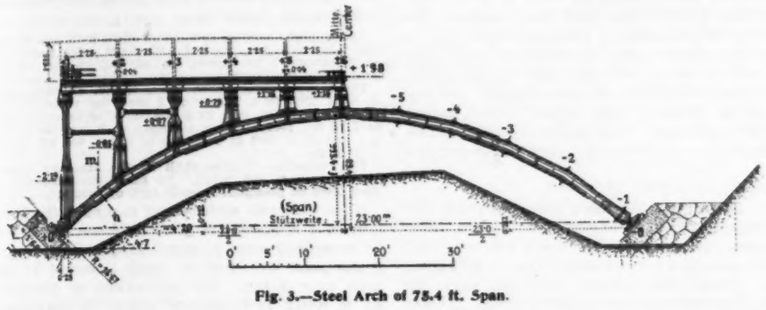

Fig. 3.—Steel Arch of 75.4 ft. Span.

Kind of Arch.	Thickness at crown. Ins.	Thickness at springings. Ins.	Ultimate load, lbs. per sq. ft.
Rough stone	23.6	43.3	660
Brick	23.6	43.3	602
Concrete	27.6	27.6	742
Monier	13.8	23.6	1,300
Steel	12.6	12.6	1,564

The stone arch was of rough quarry stone laid in mortar made of 1 part Portland cement and 2.6 parts of sand. Both this and the brick arch were tested fifty-one days after their completion, and the manner of failure was similar in each, radial cracks appearing on the extrados near the skewback on the loaded side and over the haunches on the unloaded side.

The metallic arch was formed of two ribs, 5.9 ft. apart between centers, each rib having a solid web with flanges of angles and plates, while the ends abutted against pins at the skewbacks. Failure occurred under a total load of 175,478 metric tons over the half span by the lateral bulging of the unloaded half of the arch. The iron work was not cracked, however, nor were any rivets sheared off.

The report gives full drawings and descriptions of each of these five large arches, the tests of which are, without doubt, on the largest scale ever undertaken. In the execution of the work several railway companies and manufacturing establishments co-operated in a hearty and praiseworthy manner.

Fig. 4 is reproduced from a photograph showing the steel arch and the Monier arch in position.

III. The Measurement of the Deformations.

This chapter of the report is devoted to a description of the methods of measuring the vertical and horizontal displacements, as also the angular changes in direction. It likewise gives in tabular form the observations of these displacements taken during the tests, together with those caused by changes of temperature. The data thus derived are especially valuable for confirming the elastic theory of arches when the loads give stresses not exceeding the elastic limit of the material.

IV. Tests of Materials.

This section gives detailed tables of the tests of the strength of the various materials used in the arches. We have space here only to call attention to the numerous determinations of the coefficient of elasticity of mortar and concrete, which were made both under tension and compression. For mortar 1 part Portland cement to 3 parts of sand the mean values found ranged from 5,000,000 to 6,000,000 lbs. per sq. in. For concrete the values were much lower, ranging from 1,400,000 to 4,000,000 lbs. per sq. in. For the steel used in the metallic arch the coefficient or modulus was quite high, the least value in 6 tests being 29,700,000 and the greatest being 31,400,000 lbs. per sq. in.

V. Comparisons with Theory.

The tests briefly described above furnish abundant opportunity for the comparison of the theory of arches with the observed facts, as also the data for the determination of the actual coefficients of elasticity that can be relied upon in large structures. For this purpose an exhaustive discussion of the elastic theory of arches is given, which is then applied to the different structures.

The stone arch of 74.5 ft. span is first taken up and it is shown that the strength of the mortar, in which all the cracks appeared, must have been at a mean only about 120 lbs. per sq. in., or rather this is the measure of the adhesion of the mortar to the stone. The coefficient or modulus of elasticity, as determined from the displacements before the elastic limit was reached, was found to be 960,000 lbs. per sq. in.

The brick arch of 74.5 ft. span was subjected to a similar discussion. The adhesion of the motor was found to be about 70 lbs. per sq. in., while the coefficient of elasticity ranged from 340,000 to 470,000 lbs. per sq. in.

The concrete arch of 74.5 ft. span gave the conclusion that the ultimate tensile strength was about 200 lbs. per sq. in., while the practical coefficient of elasticity was found to be 1,430,000 lbs. per sq. in., a result much lower than the mean value determined from small specimens. The beton Monier arch is not discussed theoretically, and, indeed, this would be a difficult task on account of the different materials combined.

The theoretic discussion of the steel arch is an exhaustive one, in which it is shown that the observed facts agree with the elastic theory fairly well, although the practical coefficient of elasticity is found to be only 26,000,000 lbs. per sq. in., or 15% less than the value found from small test specimens.

VI. Results and Conclusions.

The results of the tests of the arches of 75.4 ft. span are summed up by Prof. J. E. Birk. This review includes most of the facts above mentioned, as also numerous others relating to the mode of rupture of the arches. With respect to the beton and concrete arches, it is shown that rupture calls into play the tensile rather than the compressive strength of the material. For all the arches, it is shown that the theory of elasticity gives the only solid foundation for theoretic investigation, since the proportionality of deformation to stress was shown to be practically observed in all cases where the elastic limits were not surpassed. For the steel arch the agreement between the observations and the predictions of the elastic theory were in particular satisfactory, and thus the experiments have served a most useful purpose.

The report of the committee closes with a chapter on practical considerations to be observed in the construction of large arches, another giving the receipts and expenditures in full, and a lengthy appendix on methods of computing stresses in arches and determining the proper economic proportions.

The Austrian Society of Engineers and Architects is to be congratulated on having instituted this comprehensive series of tests; and its efficient committee, twelve members of which take part in writing the report, is to be congratulated on the wisdom of its plans and the great care and completeness with which they were executed. Their work indicates that the old static theory now generally used in this country for brick, concrete, and stone arches must soon give way to the more exact and satisfactory theory founded on the laws of elasticity.

THE NEW DECIMAL ASSOCIATION, of London, sends out the following items regarding the growth in popular demand, in England, for a change to the metric system of weights and measures: The London Association for the Protection of Trade, having about 4,000 members, mostly retail dealers, has sent a petition to Parliament urging the adoption by the government of the recommendations of the Select Committee, favoring the metric system. The Rochdale Merchants and Tradesmen Association has also asked for the compulsory adoption of the metric system. Other commercial bodies, in Liverpool, Edinburgh, Hull, Manchester, Munster, Bolton, Southam, etc., have all taken action showing them to be decidedly in favor of the proposed change. The significant feature of these petitions is that they come from bodies representing the retailers and smaller tradesmen, a class that would probably be most inconvenienced by a change in standards, and the class from which the strongest opposition was expected.

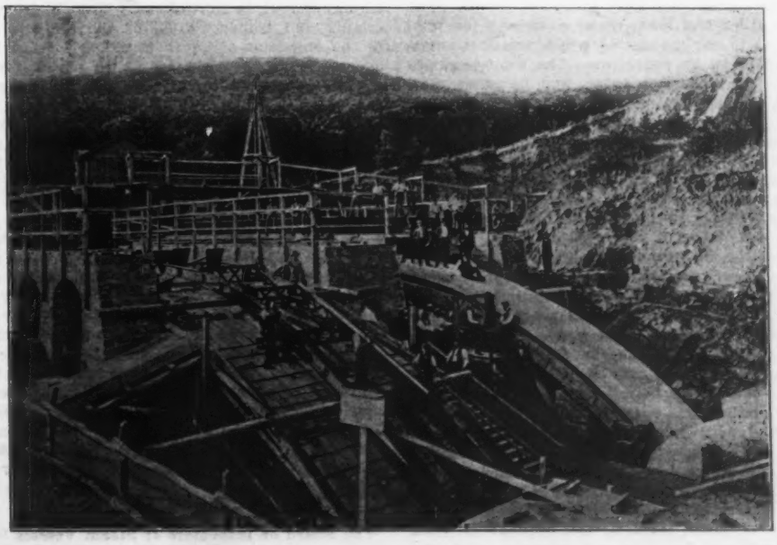

FIG. 4.—THE STEEL ARCH AND MONIER ARCH OF 75.4 FT. SPAN IN POSITION, READY FOR TESTING.

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The proposed appointment of a Legislative Commission to adjust the claims of the New Croton Aqueduct contractors against the City of New York, would be establishing a most dangerous precedent, one which would overturn the fundamental theory upon which municipalities can alone contract for public work. Such contracts must be based on specifications, setting forth the class and quality of work to be performed, must fix penalties and must make some one the final judge as to the manner in which the contract is fulfilled in all its provisions. The chief engineer is properly made this judge, and no other individual, or commission, can be so well informed as to all controlling conditions, or as to the real questions involved in disputes between the corporation and the contractors. To assume that a commission, even of well meaning, intelligent and thoroughly honest and unbiased citizens, can equally well adjust the intricate questions arising in the conduct of a large public work, is to at once destroy the authority and power of the chief engineer, and remove the only guarantee that the work finally performed fulfills all the requirements of the contract. In the possibility of the creation at any time of such a court of appeal, the contract itself would be practically a mere form, of little weight, and the door would be open to endless disputes between the contracting parties. Specifications without the power to enforce them and without a judge to fix the point and extent of infringement, would be valueless. In the particular case of the New Croton Aqueduct the principal contractors are, it is true, entitled to some sympathy; for, while enormous frauds were perpetrated, much of this scandalous work was doubtless done by subordinates, and the principals are rather to be charged with criminal carelessness than with a full knowledge of what was going on. But under any contract of this nature the principal is, and necessarily must be, held responsible for the deeds of his agents, and all bad work must be made good at the contractor's expense. Any claim now made against the city, respecting either the quantity or quality of the work done in making such repairs, is especially forbidden by the terms of the contract, and can not be justly allowed by any commission. This extra cost to the contractor by reason of these repairs is the penalty paid for bad work, which he was previously warned in his written contract would be mercilessly exacted; and this penalty is fixed with the sole purpose of compelling him and his agents to do the work as specified. As to differences of opinion regarding the reading of specifications for work not coming under the head of repairs, the chief engineer is again the best referee and judge; and he should be the only one. These differences always have existed, and they will exist so long as work is to be done by contract; and to refer each final estimate for adjustment to a legislative commission is only to increase the number and character of such disputes, and to put a premium upon insubordination and non-observance of contract law. On account of the greater evils which would surely follow its enactment this Aqueduct bill is one that should be at once and overwhelmingly defeated.

A steel billet pool, in which practically all the manufacturers of steel billets have joined, has been formed, and the price of billets has been put up to $20 per ton at Pittsburg, a rise of $3 above previous prices. The pooling companies agree to limit their production for April to from 220,000 to 250,000 tons. Last year they produced 3,000,000 tons of Bessemer steel. At the higher limit the selling price of this product would be $5,000,000 per month, a figure which shows that the pool is probably the greatest that has ever been formed in any manufacturing industry. The effects of this pool upon the steel industry, if it is kept up for any length of time, may be far reaching. Steel billets being only an intermediate product, halfway between pig iron and finished plates or bars, the arbitrary advance of price places the finishing mills at the mercy of the billet makers, for the latter also have finishing departments, which can in times of severe competition in the market for finished products receive billets at cost, while their competitors, the smaller finishing mills, have to pay pool prices. The pool will be a temptation to the billet producers to take advantage of this state of affairs and erect more finishing mills, and the owners of finishing mills only will be compelled to erect complete steel plants or be driven out of business. Thus the constant tendency grows to concentrate the steel industry into the hands of a few concerns having capital enough to control every branch, from the mining and transportation of the ore and coal to the shipment of goods in shape for the final consumer. If the producer of tin plates, for instance, wishes to buy tin-plate bars, he must pay pool prices. He would like to put up a tin-bar mill to roll the bars from ingots, but ingots are not a marketed article, and he must put up a Bessemer plant. If he does this he would then have to buy pig iron, on which there are no pool prices, but which is made from pooled ore and pooled coke, transported on pooled railways. To economize in making steel, he would build blast furnaces, and then the ore and the coke men would squeeze him, and he must buy ore and coal lands and build coke ovens, and finally enter the pool of producers of raw material who have the grip on the whole trade. We have said that there are no pool prices on pig iron, but there soon may be. The blast furnace companies in Birmingham, Ala., and vicinity have established a joint selling agency, by which competition among themselves may be stopped, although they still will have to meet, in the North, the competition of Northern irons, which as yet are not under the control of a pool.

The Board of Inspectors of Steam Vessels have made another change in their rules for testing plates to be used in steam boilers. The method of adopting rules by this Board seems to be to get the manufacturers of plate to say what specifications they would like to have, and then give them what they ask for. As a consequence, the shape of test piece specified by the rules of the Board for testing boiler plates made of iron has been for the past 20 years so bad that it has been condemned by every engineering writer who has had his attention called to it. Up to 1894 these rules applied also to steel, but since that date the shape of test piece for steel plate has been made different from that for iron plates. In 1894 the tensile test piece for steel was specified to have the straight portion of a length at least eight times the width multiplied by the thickness, and of a width of 1 in. Why the standard length of 8 ins. between gage marks, adopted almost universally by testing engineers both in Europe and in the United States, was not chosen, we cannot imagine. The new rule, which is said to have been adopted after considering the changes urged by representatives of steel plate manufacturers, specifies the following:

> The straight part in the center shall be 9 ins. in length and 1 in. in width, marked with light prick punch marks at distances 1 in. apart, as shown, spaced so as to give 8 ins. in length.
>
> The sample must show, when tested, an elongation of at least 25% in a length of 2 ins., for thickness up to ¾ in., inclusive; and in a length of 4 ins. for over ¾ to 7-16 in., inclusive; in a length of 8 ins. for 7-16 to 1 in., inclusive, and in a length of 6 ins. for all thickness over 1 in.
>
> The reduction of area shall be the same as called for by the rule of the board. No plate shall contain more than .06% of phosphorus, and .04% of sulphur.

If we correctly understand this rule, the elongation of a specimen of plate 0.24 ins. thick would be measured over a gaged length of 2 ins., but if the plate were 0.26 in. thick it would be measured over 4 ins. The allowance of phosphorus up to 0.06% is extremely liberal to manufacturers, and it would indicate that they had a good deal to do with framing the specification.

The steel manufacturers themselves have also recently established a "standard specification" for testing, which, although a good deal better than the specifications above quoted, is still deserving of criticism. We quote from it as follows.

> The elongation shall be measured on an original length of 8 ins., except when the thickness of the finished material is 5-16 in. or less, in which case the elongation shall be measured in a length equal to 16 times the thickness; and except in rounds of 5-8 in. or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested.

By this specification, if the test specimen had a thickness of 5-16 in. or a diameter of ⅝ in., the elongation would be measured over a length of 5 ins., but if the thickness or diameter were a trifle greater, it would be measured over 8 ins. The liberality of the manufacturers, to themselves, is shown in these specifications in the absence of any requirement as to phosphorus, and also in the provisions that in structural steel only two test pieces shall be taken from each melt or blow, one for tension and one for bending, and in boiler plate steel only four test pieces are to be taken, two for tension and two for bending.

No doubt the steel manufacturers consider that they have good cause for framing specifications upon which their customers shall order steel, in the annoyances to which their works are sometimes subjected caused by the great variations in specifications framed by different customers and by different engineers, boards of inspection, testing laboratories, etc., but the principle of a manufacturer framing his own specifications is a bad one. If the great variety of specifications now existing is an annoyance and an obstruction, there should be a better way of removing the annoyance than the one of adding to those already existing a new set which is more objectionable from the standpoint of an engineer, than most of the old ones. There are now in existence specifications for boiler plates framed by the British Board of Trade, the British Lloyds, the American Shipmasters' Association, the American Boiler Makers' Association, the U. S. Navy Department, the U. S. Board of Inspectors of Steam Vessels, the Pennsylvania Railroad Co., and we know not how many others, together with the specifications of various private testing laboratories and individual engineers. It would appear desirable that a conference of the several parties interested in the question should be held with a view of establishing uniformity in specifications; such a conference, say, as was recently held in New York city for the purpose of establishing uniform rules for electrical wiring of buildings.

In this connection we would call especial attention to that feature of the steel manufacturers specifications for boiler plate steel which calls for only two tension test specimens to be taken from a heat or blow of the steel. A heat may

contain anywhere from 20 to 40 tons, while a boilermaker may have occasion to place orders for only a ton or two of plates at a time. It is of the utmost importance that no plate shall be used in a steam boiler of which the quality is not known. There is danger in many, if not all, steel works, making many varieties of steel, that ingots may become mixed in transferring from the casting pit to the rolling mill, or in the heating furnace. This danger can be guarded against only by testing a shearing from every plate rolled. Such a test also is a precaution which should be adopted to detect plates that have been overheated or rolled too cold. The practice of the Pennsylvania Railroad Co. of requiring a "coupon" to be sent with each sheet of firebox or boiler-plate steel, we regard as the only really safe one. It entails a little extra trouble and cost to the manufacturers, of course, for which they are entitled to charge, but in view of the great danger of allowing plates of improper quality to get into a steam boiler, it would seem that it should be universally adopted.

THE CHOICE OF LOCATION FOR MANUFACTURING PLANTS.

The United States will ere long enter an era of great development of its manufacturing industries, equal to, if not exceeding, that which took place in the five years preceding 1893. The outlook at the immediate present, with its pending elections and with its uncertain prospect of sound financial and revenue legislation, may not seem hopeful; but the present conditions are but temporary, and there can be little doubt that the present depression will be followed, as all previous ones have been, by a great industrial revival. Notwithstanding the cry of hard times which is still heard, the great body of the workmen of the country are now employed, and the actual wealth of the country, measured in quantity of goods produced, is steadily increasing. The farmers are doing fairly well, the workers in iron are producing and putting into finished shape more iron and steel than at any previous period, the miners are producing more gold, if not more silver, and more coal, copper and other metals than ever before. Population is steadily increasing by natural growth, and immigration has not ceased. Capital is still timid of investment in new enterprises, but it is being piled up both in this country and in Europe; and when the present financial and political disturbances have quieted down, vast amounts will seek investment. The increase of population and the increase of wealth per capita will create an increased demand for manufactured goods, and there seems to be no field for future investment of capital that is, on the whole, so promising as that of providing new factories to supply the new demand.

Manufacturing is now the leading industry of the United States, measured in the value of goods produced, taking precedence even of agriculture. According to the last census, the value of manufactured products in 1890, after deducting the value of raw material, exceeded $4,000,000,000. The total value exceeded $9,000,000,000, according to the returns, but this figure, of course, includes many duplications, the finished product of one factory being the raw material of another. The increase in total value from 1880 to 1890 was over 50 per cent., while the population increased less than 25 per cent., and this increased value was made in the face of great reductions in prices. The consumption of manufactured articles since 1890 has undoubtedly increased faster than the population and faster than the consumption of agricultural products, and this condition of things will inevitably continue with increase of wealth, since the consumption of food products is limited by the capacity of the stomach, and that of manufactured goods only by the ability of the people to buy them. But notwithstanding this increased demand for goods and the consequent increased demand for new factories being thus certain, it by no means follows that manufacturing will become universally profitable to every one engaged in it. The consumption of pig iron in the United States has quadrupled in the last 20 years, but vast fortunes have been made by a few only of those engaged in pig iron production. Since 1875 there has been a revolution in the iron trade, the production of 1895 was made in fewer furnaces and by fewer firms than that of 1875, and the growth of the industry has been accompanied by the abandonment of hundreds of once prosperous furnaces, and by the failure or liquidation and retirement from business of hundreds of firms. In other branches of manufacturing, similar changes have taken place, although, perhaps, to a less degree. The Southern cotton manufacture threatens the existence of many New England mills, and there is a general tendency to migration of manufacturing toward the West and South.

However fast may be the increase in the demand for manufactured goods, there need be no fear that the capacity of the factories will not keep step with it and go beyond it. Since 1875 there have been only a few months, in the latter half of 1879, when there was even apparently a lack of sufficient producing capacity among manufactories generally, and the fear of a shortage of iron which then occurred at once led to such a rapid building of iron furnaces and such a rapid driving of those already in existence that the production soon caught up to the demand, and the capacity for producing has never been fully utilized since that date. The same surplus of producing capacity is now characteristic of practically all manufacturing industries. The result of this is a constant competition among manufacturers, by which each strives to get more than his share of the trade, and a constant tendency to reduction of prices and of profits, and to reduction of costs. Only the fittest survive; those with ample capital, good locations, and good business ability grow into large establishments, and those not so well favored drop out of the race.

The conditions of the manufacturing industries of the United States have heretofore in general been far more favorable to the manufacturer than have those of England, but the increased competition which now exists here is bound to reproduce the same conditions which have long existed in England. What those are is well shown in the presidential address of Mr. David Dale, delivered before the Iron and Steel Institute of Great Britain in May last, an extract from which we give below:

> In view of our enormous actual capacity of production and the added latent capacity potential in the vast accumulated wealth which is ever waiting to flow into any channel which seems to promise even a moderate percentage of return, competition even within our own borders is practically unlimited. The inevitable logical sequence from this state of things, is that our production will continue to be put on the market at a price very closely corresponding to the cost. Works will continue to be carried on in the vague hope of "better times," on a basis of selling price which will cover the wages of the workmen and the expenses of management, but with the margin available as dividends for the expectant investor reduced to a vanishing fraction. This price, too, will be set by the concerns most favorably situated for economy of production, whether by natural advantages of situation, most perfect appliances or scale of operations. . . . The operation of the inevitable and inexorable law (the survival of the fittest) will ever tend to eliminate the less favorably situated, and to concentrate production in the hands of those vast concerns whose resources are such as to enable them to maintain the struggle in exceptionally hard times, as well as to avail themselves of every improvement in processes of manufacture, upon the adoption of which their continued existence will depend, and which are denied to their less favorably situated competitors.

In the near future, as we have already stated, there will be in the United States a great development of manufacturing industry, and a great increase in the number of new factories, while at the same time there will be a struggle for success between the old and the new in which many of the old ones will be driven out of existence. As in the past, so in the future the success of a factory will depend upon four principal conditions: 1, abundant capital; 2, good location; 3, the most modern machinery; 4, good management. In times of average prosperity a concern may succeed with one or other of these conditions lacking, but in times of depression, which are likely to occur periodically as they have done heretofore, the possession of all four will be necessary to secure profits if not to maintain existence at all. Profits are likely to average lower in the future than in the past, whether figured as a percentage on the capital invested or as a percentage on the value of the goods produced. It is, therefore, more essential than ever before that a new establishment be provided with all four of the above-named conditions for success.

Suppose that a capitalist organizes a new manufacturing project, it requires no special foresight or knowledge of the business to secure good managers for the business, but only the exercise of ordinary common sense. Such management being thus provided, in league with sufficient capital, it follows as a matter of course that the best machinery will be obtained, so now we have three of the four essentials of success obtained without any especial difficulty.

The question of location, however, is one which cannot be settled without a profound knowledge of the history of the particular business, of its technology, of the location and cost of its raw materials, of the geographical position of its rivals, of freight rates, of the location and extent of the principal markets for the product, of the available labor supply, and of rates of wages, besides a foresight into the probable future of the trade and of the shifting of the sources of supply of the raw material and of the markets. The probabilities of labor troubles must also be considered, and the influence of possible changes in rates of wages in different districts, and of changes in tariff legislation. All these various elements of the problem render the question of location an exceedingly complex one, and its solution will tax the judgment and the foresight of the heads of the concern to the utmost. In the selection of the proper location the judgment of the wisest manufacturers is apt to be erroneous, and the foresight of the wisest may not be sufficient to guard against unexpected new events which may change a good location into a bad one.

A recent instance may here be mentioned. A few years ago the Maryland Steel Co. spent $5,000,000 in building one of the finest steel works of the world near Baltimore. The apparent advantages were a location on tide water, the very best in the country for receiving supplies of ore from Cuba and other foreign countries, and for the shipment of its products to all points on the Atlantic Seaboard and on the Gulf of Mexico, and a convenient point for receiving both Pocahontas and Connellsville coke. The management did not foresee, however, the great decline in the demand for steel rails, the wonderful discoveries of ore in the Mesaba range of the Lake Superior region which gave great advantages to its Western rivals, and finally the Cuban war, which stopped its principal supply of ore. In consequence, the concern became bankrupt, and went into the hands of a receiver. By a reorganization with fresh capital it has been enabled to start again, and by the advance in the prices of Lake Superior ore, and by finding other outlets for its product than the market for steel rails, it may yet have a prosperous career.

Another error of judgment in location has been seen in the career of scores of blast furnaces built in the South within the past ten years, the owners of which, attracted by the success in making cheap iron of the furnaces of the Birmingham, Ala., district, failed to see that the competition of the Birmingham furnaces alone would reduce selling prices to such a low point that only those with exceptional locations could survive at all. The market for foundry pig iron was sufficient for only a certain number of Southern furnaces, and the building of a surplus number only hastened the bankruptcy of all except the more highly favored.

The building of large cotton mills in the South is already inaugurating a new struggle for existence between the cotton mills of the North, of which no outsider can predict the outcome. Will the advantage of water power which Lowell and Lawrence possess over Fall River overbalance the advantage of cheaper fuel and cheaper freights on raw cotton and on finished product of the latter? Will not the superior advantage of the South in still cheaper fuel, cheaper labor and nearness to the cotton fields ultimately restrict the cotton manufacture of the North to the production of the finer grades?

In considering the question of location of a new manufacturing plant, the comparison of the relative merits of different proposed locations involves a great number of different elements,

and it is worth while to systematically enumerate them:

1. Nearness to Residence of the Owners.—This is often the controlling condition which decides (whether rightly or wrongly) the location of a new works. A capitalist likes to build a factory in his own town or village, where he can continuously watch its operation with the least personal inconvenience. Many works have been badly located by giving too great weight to this one condition, but the error has often been counterbalanced by the increased benefit due to personal supervision of the owner, and to his pride, which will induce him to provide the works with sufficient capital and the best possible machinery and management. Well-located works sometimes fail, because they are too far from the residence of their owner for him to take a personal interest in their management.

2. Cost of Freight on Raw Materials to the Works and on the Finished Product to its Chief Markets.—A score of years ago this was generally considered the paramount consideration in choosing a location for a manufactory. Railway rates were then fixed by the rule of what the traffic would bear, which meant that the owner of a factory in a country town, depending on a single line of railway for transportation, was charged upon his shipments as much as the railway managers considered his profits would warrant. On the other hand the manufacturer located at a point where several competing railways centered, practically bought transportation of the lowest bidder. These conditions gave an enormous stimulus to the growth of every town where railway competition existed. The cities of the West engaged in an eager struggle to secure the greatest possible number of competing railway lines in order to secure the greatest number of manufactories.

But the much-maligned interstate commerce law has changed all this. The long and short haul clause has put a permanent stop to the practice by a railway of bleeding its local shippers; and there are now many reasons why a location in a small town served by a single railway company is preferable to one at an important railway center. One of these reasons is the facility of securing cars for shipment. At a large and important center like Chicago or Buffalo or Philadelphia, there are often annoying delays in the receipt or delivery of freight cars due to the network of terminals which must be passed to reach a given point. A factory located at a country town with its own private siding has no such trouble; especially if it is a large establishment and pursues the common policy nowadays of owning its own special cars.

3. The Cost of Motive Power.—In the early part of this century this was the paramount consideration in locating a manufacturing plant. Water power was then practically the only reliable motive power. The chief manufacturing cities of New England were built up from small country villages during the first half of the century solely by their excellent water power. But the perfection of the steam engine has wrought a great change. In most industries at the present day the cost of motive power is such an insignificant fraction of the annual expenses that it hardly comes in as a factor in choosing a location for a manufactory. Of course in certain industries, such as paper manufacture, or processes requiring great amounts of electric current, a site where cheap power is available is important. In considering the matter of cost of motive power and the comparative merits of steam and water power, however, in weighing the advantages of relative locations for a manufactory it should be remembered that the use of exhaust steam for heating purposes will often greatly reduce the actual cost of motive power during the winter months.

4. The Labor Question.—In most industries, it is not too much to say that this is likely to prove the most important question with respect to the choice of locations for a new manufacturing enterprise.

The prevalence of strikes in certain great manufacturing towns during the past decade is having a marked influence in attracting capital toward investment in new mills located far from the scenes of labor disturbances and in districts whose reputation for the observance of law and order is such that the manufacturer can be assured of protection to his property in case of emergency. It is to be remembered that in case of a strike, the manufacturer is often more likely to suffer injury from the hoodlums, outlaws and semi-criminals, who flock to every scene of disturbance, than from his own striking employees. A factory located within the region covered by the police protection of a great city like New York, Chicago or Philadelphia will be, indeed, a mark for attack by mobs of this class in case of a strike, but the police protection can generally be counted on to prevent serious loss. On the other hand, if a factory is located in a country town, its owner has no police protection of much account on which to rely, but he has also little need to fear violence or incendiarism, except from his own employees, and if he is wise,he will see that no bad and dangerous characters are ever numbered among them. But the manufacturer who locates in a city whose population is and has for years been made up largely of factory employees is likely to suffer severely in case of a serious strike. Most cities of this class have a large "tough" element, and a police force that is generally too small to cope with it. A notable illustration of the facts just noted is Paterson, N. J., which has long been the chief center of the silk industry in this country. In recent years silk factories have been established at Allentown, Scranton and Carbondale, Pa., and in North Carolina, largely with a view of avoiding the labor disturbances which have proved so disastrous in Patterson.

The Comparative Advantages of City and Country Locations for Manufactories.—One of the most interesting questions in connection with this subject is whether a city or country location is preferable as the site for a manufacturing establishment. In the past the tendency has certainly been toward the cities, and it is not at all improbable that the phenomenal growth of cities at the expense of the country towns which has taken place in the past two decades has been due largely to the building up of manufacturing enterprises in the cities and the inability of their rivals in country locations to compete with them. There is reason to believe that in the future this condition may be reversed, and that the most advantageous location for manufactories may be found in country towns and small cities. In the matter of transportation facilities, there are thousands of places in the United States where a factory may be built on land costing no more than farm property but from which better transportation facilities can be secured than could be had in any great city save for a fabulous sum. Motive power in a country location can almost invariably be obtained for less than in any great city, where cost of cartage of fuel, ash removal, and insurance are very heavy items. By adopting electric transmission, water power can frequently be developed and made use of for country manufactories at a moderate figure.

As for the labor question it is quite true that the manufacturer who locates in a country town has to take some pains to secure skilled employees at the outset; but he has an opportunity to train up and secure to himself a permanent force of skilled workmen of good character which the city employer does not. The cost of living according to a decent standard of comfort is far more in the city than in the country. Thus the country manufacturer can pay his employees lower wages and still secure a higher grade of workmen, who will be much better off than the tenement-house dwellers employed by his competitor in the city. Further, by good management, the country employer can to a large extent avoid strikes with their attendant losses and dangers.

As notable examples of the building up of successful country factories we may mention the felt works at Dolgeville, N. Y., the Westinghouse enterprises at Wilmerding, Swissvale and East Pittsburg, and the Fairbanks works at St. Johnsbury, Vt. Of course the fact will not be lost sight of that the factory established in the country has a great advantage in being built on cheap land. Thus the buildings and yards designed can be of whatever form is best suited to the work to be done, whereas in a crowded city land is too costly to permit any but the most compact arrangement. Of course, when a factory is located in the country it is also possible for the founders to secure large tracts for employees' cottages and other buildings; and either enable the workmen to secure building lots at a nominal figure or place a sum in the treasury of the manufacturing company sufficient to pay for the land which it occupies, and often for a considerable part of its plant.

Certainly economists and humanitarians will welcome anything which tends to divert population from city slums and tenement houses and scatter it in country villages.

The forces of a social character which draw population to the great cities are strong enough to make a continued growth of the great populous centers a certainty. It will be a great boon if this growth is to be checked and brought within reasonable limits by the forces of competion, operating to build up the smaller manufacturing cities and especially to foster the growth of manufactories in the small country towns.

The Concentration of Industries.—A noticeable feature of manufacturing development is the tendency to concentrate a special class of industries in a single town or locality. In some cases there is sufficient reason for this in the proximity to some source of raw material, but in other cases other reasons for the concentration must be sought. Thus Lynn and Haverhill and Brockton are famous shoe towns, Holyoke is famous for its paper mills, Fall River is a cotton mill city, Springfield, O., is a center for mower and reaper manufacture, Grand Rapids, Mich., is "headquarters" for furniture, Amesbury, Mass., is noted for its carriages. A variety of reasons have brought about this concentration. One is its well-known advantages in connection with the marketing of the product. Another is the facility of obtaining skilled and experienced labor. Still another and very important one is the ability to divide up work among different factories, one establishment performing a single operation and passing it on to another. Again in a town devoted to a single industry shops for the manufacture and repair of the special machinery used are to be found, which save the necessity of the maintenance of a repair department by each factory.

In general the principle may be laid down that if a large establishment with ample capital is to be established at the present day, there is very little advantage in locating it in a town or city devoted to that particular industry, provided another site has equal or better facilities of the classes enumerated under four heads above. A small establishment, however, may do best in a town devoted to its specialty.

Distribution of Manufacturing Industries in the United States.—A study of the census statistics of manufactures is of interest as showing which states lead in each industry, and it is found that various causes contribute to the preponderance of manufacturing industries of a given class in a given state. In the accompanying table, compiled from Census Bulletin, No. 380, the three leading states in each of 22 leading manufacturing industries are given. It will be seen that Minnesota leads in flour production and Pennsylvania in iron and steel production because of their nearness to the raw materials of these industries. Illinois leads in agricultural machinery and New York in bakery products because of their nearness to the populations which furnish a market. Massachusetts leads in boots and shoes and the textile industries, because of her enterprise and ability in undertaking and building up these industries in advance of other states.

In general the tendency appears to be more and more to a spread of manufacturing industries more generally over the country. So far as local conditions and supply of raw materials will permit, each section is likely to tend more and more to establish its own manufacturing industries. No

modern nation is content to export raw materials and import all its manufactured products, and this same principle is already being acted upon by the various states of the Union. The days when the manufacturing industry of the United States was centered in New England and the Middle States have gone never to return.

The Location of Principal Manufacturing Industries in the United States.

(The figures after the name of each state represent the number of million dollars worth of product during the census year.)

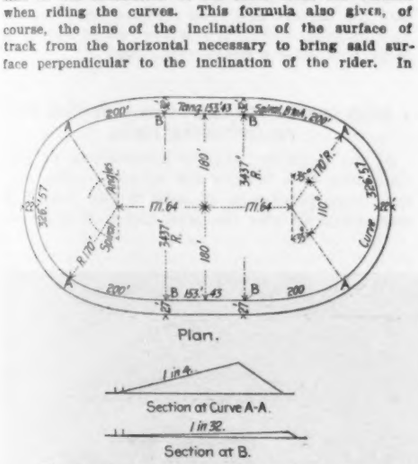
Agricultural implements....Ill. 25; Ohio 14; New York 12
Boots and shoes..Mass. 116; New York 24; Pa. 10; Me. 10
Bread and other bak'y prod's..N. Y. 33; Pa. 16; Mass. 11
Carpentering.....N. Y. 45; Mass. 34; Pa. 27
Carriages and wagons.....Ohio 19; N. Y. 17; Ill. 9
Clothing, men's, factory made..N. Y. 97; Ill. 34; Pa. 27
Cotton goods.....Mass. 100; R. I. 27; N. H. 22
Flour and grist mills..Min. 60; N. Y. 53; Ohio 39; Pa. 39
Foundries and machine shops..N. Y. 72; Pa. 68; Ohio 44
Furniture.....N. Y. 20; Ill. 14; Mich. 9
Iron and steel.....Pa. 249; Ohio 57; Ill. 37
Leather, tanneries, etc.....Pa. 39; Mass. 21; N. Y. 20
Liquors, distilled.....Ill. 52; Ky. 15; Ohio 12
" malt.....N. Y. 53; Pa. 18; Mo. 17
Lumber, saw-mill product.....Mich. 73; Wis. 52; Pa. 28
" planing-mill product...N. Y. 34; Ill. 20; Pa. 18
Masonry, brick, stone, etc....Pa. 28; N. Y. 27; Mass. 18
Printing and Pub'g, books, etc..N. Y. 24; Ill. 15; Pa. 13
" " " newspapers..N. Y. 44; Pa. 20; Ill. 17
Slaughtering and meat p'k'g*..Ill. 200; Kan. 45; N. Y. 35
Sugar refining.....Pa. 47; Cal. 23; N. Y. 17
Woolens and worsteds.....Mass. 57; Pa. 48; R. I. 32

*Wholesale.

LETTERS TO THE EDITOR.

The Cycle Track at El Paso, Tex.

Sir: I was interested in the description of the excellent cycle track at Manhattan Beach given in your issue of March 19 and enclose you herewith a blue print of the plan of the three-lap cycle track at El Paso, Tex., designed and built by the writer during August and September, 1894, for the El Paso Cycle Track Association. The long spirals B A were selected to give a very gentle transition into the curves A A and afford ample distance from B to A for raising the banking due to the radius (170 ft.) of the curves. The amount of banking from A to A was determined by the following formula, viz.: $\frac{W \times V^2}{32^2 \times R} =$ sine of the inclination of the rider from the vertical when riding the curves. This formula also gives, of course, the sine of the inclination of the surface of track from the horizontal necessary to bring said surface perpendicular to the inclination of the rider. In



Plan of Bicycle Race Track at El Paso, Tex.

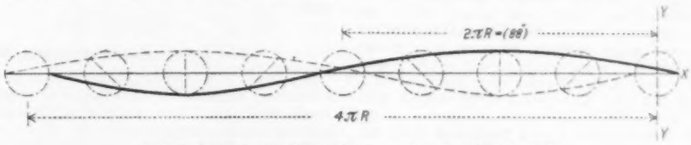
the formula, W is always equal to unity or 1. For the El Paso track I assumed the velocity V equal to 40 ft. per second and supposed the rider to be 10 ft. from the "pole," which made R the radius equal to 180 ft. This gives $\frac{1 \times 40^2}{32^2 \times 180} = 0.24+$ or practically an inclination of 1 in 4.

The embankment of the track is of earth and sand, and the surface is finished with a layer of excellent natural concrete composed of pulverized granite, clay and silica admirably mixed by nature and existing in unlimited quantities in this section. This natural concrete forms a most excellent surface and is exceptionally live and elastic. The total cost of the track was about $2,000. It has given excellent satisfaction.

El Paso, Tex., March 24, 1896. J. L. Campbell.

The Curve Traced by a Bicycle Pedal Pin.

Sir: I noticed in a Chicago daily paper last summer an illustrated discussion of the curve traversed by the pedal pin of a bicycle. Noting that the curves given were mere guesses, and being convinced that they were also far from being correct, I worked out the following solution of the problem which may be of some interest to your readers. The diagram represents the curves traversed by the pedal pins of a bicycle running in a straight line along a horizontal surface and of the following dimensions: diameter of rear wheel, 28 ins.; radius of pedal circle or length of pedal crank, 6 ins.; ratio of gears, 2 to 1. The curves are those made in one complete revolution of the pedal cranks or two complete revolutions of the rear wheel, starting from the position when both pedals are in the same horizontal plane. Referring the curve to rectangular co-ordinates with the origin as shown at the center of the pedal circle at the starting point and taking as the axis of X the horizontal line



THE CURVE TRACED BY A BICYCLE PEDAL PIN.

traversed by the center of the pedal circle, the curve may be represented by the following two equations:

$$x = -r\theta R + a\cos.\theta \text{ and}$$
$$y = a\sin.\theta,$$

or combining the two into one equation containing the three variables,

$$x = -r\theta R \pm \sqrt{a^2 - y^2},$$

where θ equals the angle of revolution (in circular measure) of the pedal crank, measured in the usual way opposite to the direction of movement of the hands of the clock, taking the value $\theta = 0$ for the position coinciding with the X axis to the right, and where r = ratio of gears, R = the radius of the rear wheel, and a = the radius of the pedal circle. The last equation given is incomplete without the second,

$$y = a\sin.\theta.$$

The proper algebraic sign must be used with the sine and cosine of θ. Very truly yours,

Chicago, Ill., Feb. 22, 1896. H. P. Boardman.

Proper Nomenclature in Engineering Literature.

Sir: You are sound in asserting that the English language is not to be changed at the will of any set of writers. Without any personal claim of perfection in regard to this matter, I am glad you have taken up the use of "moment of resistance," "strain," etc. My written notes of Prof. B. F. Greene's lectures on Mechanics, 1856-7, gives "moment of resistance" as RI÷z.

In connection with this general subject I would like to protest against two other errors of a similar kind. A former publication committee of the American Society of Civil Engineers ruled out the use of the word "lineal" and substituted "linear" in lineal foot, inch, etc.

Whether I am right or not in believing that in connection with units of measurements "lineal" is the older and better form, what right has any one to rule out a word from the English language?

Another absurd innovation is the use of the word "lacing" to replace "double latticing." Lacing is defined by Webster as "a fastening with a string or cord through eyelet holes," "a cord used in drawing tight or fastening." A lattice is "any work of wood or iron, made by crossing laths, bars or rods, and forming a network." As we lattice our bridge parts together to obtain greater rigidity, it is absurd to call it lacing. Single and double latticing covers all the needs.

Theodore Cooper.

35 Broadway, New York, April 4, 1896.

(We have also received a letter with a request that it be withheld from publication, in which the writer states that he also opposed the use of the word "strain" with the meaning assigned to it by physicists, but was obliged to give in, finding the need of a single term to express "displacement in opposition to simultaneously existing stress in the line of action of that stress." Elongation, compression, distortion and displacement are all special terms, and writers on mechanics feel the need of a general term which shall cover them all. We appreciate the force of this argument, and also the fact that mathematicians, and not engineers, were the first to give "strain" its arbitrary significance. —Ed.)

The Work of the Steam Users' Association.

Sir: My final rejoinder in our "amusing" discussion is that I perhaps might have modified the expression "great waste in the best boiler practice." I hope you will not impute even to a duffer a lack of knowledge of the fact that in some few instances 75% of the efficiency of coal has been attained in boiler practice; but as you well remark, the common practice is far below that standard. It would, however, develop a very "amusing" side to this discussion if you would send, say to the ten masters of steam engineering, a few questions as to how to get 75% of efficiency, in what boiler, how set, how fired, etc. You would then be on the line of investigation of the Steam Users' Association. The writer has always found his function to be that of a hyphen, -, a heretofore missing link between the masters of technical science and the practical man by whom that science must be put into daily practice. His effort therefore is to bring the masters of science to some sort of an agreement and then to wrest from their technical terms the lesson by which that science may be converted into an art of common practice and to put that into plain English, so that a great many practical men when they read the text will think that they found it all out for themselves. That is the way to assure success in practice. It is a very "amusing" profession.

Most truly yours,

Boston, April 4, 1896. Edward Atkinson.

(We are content to let Mr. Atkinson have the last word in this "amusing" discussion, and are glad that he has so far benefited from our remarks on his previous letter as to be willing to modify his statement that there is "great waste in the best boiler practice." We do not wish to steal any of Mr. Atkinson's thunder by embarking ourselves in an investigation similar to the one he is conducting, and therefore shall not "write to those ten masters of steam engineering" (whose names, by the way, we don't know), to ask the questions Mr. Atkinson suggests. If he will do this himself, however, and will send us the replies of the "ten masters" as to how to get 75% efficiency, we will undertake to obtain an expert review of them in "plain English," and we doubt not it would lead to the production of a valuable circular from the Steam Users' Association.—Ed.)

Concerning Rock-Filled Dams.

Sir: In the report of the Nicaraguan Canal Commissioners, printed in your issue of March 26, I notice some statements relative to rock-filled dams which are incorrect, and I therefore write that the publication of this letter may correct misapprehension on the part of engineers who may read that portion of this report.

"A" to "B" Flat and Valley Filled 10 Feet deep with Debris from Flood.
"C" shows Point where Cabin 60 ft above Stream was Carried away and Occupant Drowned.
Contour Interval 500 Feet.
0 2 4 6 Miles.

Sites of Bowman and English Dams (From Maps of the U. S. Geological Survey).

The Commissioners state that the failure of the English dam caused a flood of 166,000 cu. ft. per second to pass over the crest of the Bowman dam, and cite this as the only instance they are aware of in which a rock-filled dam has withstood such a flood as a weir. I am thoroughly familiar with the location of both these dams. I have visited them several times and in 1883 and 1887

made a topographic map of the region surrounding them for the U. S. Geological Survey. I send you copies of the Colfax and Downieville sheets of that survey, from which you will observe that the English dam is on an entirely different drainage system from the Bowman dam, the former discharging into the Middle Fork of the Yuba, the latter into the South Fork. It would have been absolutely impossible for the discharge of the English dam to pass over the Bowman dam, as a high ridge intervenes between the two drainage courses. There are various flood marks all down the Middle Fork of the Yuba north and east of Bowman from which I am sure that the water from the English dam did not perform the impossible act of reaching Bowman drainage. Therefore, any conclusions which were drawn as to the ability of the Bowman dam to withstand such a flood are unproved. I feel rather confident, moreover, that though the Bowman dam is unusually well constructed for a rock and crib dam, that it would never have withstood such a flood as resulted from the bursting of the English dam. The waters of that flood tore down the canyon of the Middle Fork of Yuba river with a flood crest 50 to 100 ft. in height, and with such velocity that great masses of rocks and trees and buildings were cast up on the canyon side 50 and 100 ft. above the stream bed.

On the other hand, I do not think the English dam burst from the giving way of decayed timbers, though that would not have been unlikely as it was not well constructed. I was informed by the watchman and some men who lived a short distance below the dam that the loud explosions which accompanied the bursting of the dam sounded to them like the explosion of dynamite. Two strangers were seen running away after the explosion. As the excitement was high in that region during the litigation between the hydraulic miners, the results of whose work were destroying the agricultural lands in the valley of the Sacramento, and the agriculturists, there was a secret organization which was prosecuting the miners and which ultimately ended in Judge Sawyer's celebrated injunction against hydraulic mining, and it was believed that the destruction of the English dam was due to an incendiary act on the part of the agriculturalists in Sacramento valley, though this was not proved.

My "Manual of Irrigation Engineering," published by Wiley & Sons, also my report in the Thirteenth Annual of the U. S. Geological Survey, gives some further information relative to these two structures, which are in no sense rock-filled dams, but really ballasted crib dams.

I know of no instance in which a loose rock dam, such as the proposed Ochoa dam, has ever been subjected to the test of having water flow over its crest as a discharge weir. There was built in 1893, across the Bruneau River, Idaho, a true rock-filled dam, 20 ft. in height with very flat slopes, and constructed under circumstances entirely similar to those anticipated in the case of the Ochoa dam. There was a considerable depth of river gravel and clay which formed the natural river bed. Loose rock was dumped on this, resulting in the scouring out of the gravel and sand, and as it was scoured out the loose rock filling was continued, the latter finally reaching permanent bed rock at 10 or 15 ft. beneath the surface of the original gravel. After coming to rest on this firm rock, the loose rock dam was continued until its total height was 20 ft., and it has since safely withstood several heavy floods. This loose rock dam did not silt up, however, so as to become impervious, water passing freely through and over it, accordingly gravel, sand and clay were dumped on its upper face and were washed into its interstices, making it not impervious, but comparatively so, in the manner suggested by the Commission for the Ochoa dam.

The Walnut Grove dam cannot be said to have failed simply because it was topped by a flood. It is possible that it would have failed from this cause, but, as shown in the "Manual of Irrigation" and in more detail in the Thirteenth Annual Report of the Geological Survey, there is almost incontrovertible evidence to prove that its failure was due to the fact that it was not founded on firm rock but that a portion of it rested on gravel, which was washed out, thus undermining and lowering the loose rock fill, consequently causing its destruction.

Very sincerely, Herbert M. Wilson.

U. S. Geological Survey, Washington, D. C., March 31, 1893.

Sewer Intersections at Baltimore, Md.

Sir: Noticing the answers to the queries of Mr. Herman D. Ruhm, Engineer of the Nashville Sewerage Co., I would state that I have planned and constructed sewer junctions in two different ways, the one by a chamber or a conical section, as it may be called, and the other by the natural junction of the arch of the smaller sewer with the arch of the larger one, preserving the natural formation of the junction of the two arches, and as a consequence the uniformity of the cross-section of the water. Of the first I have constructed a number, the angles varying from 20° up to 35°. Of the latter I have constructed four, the angles varying from 16° 15′ to 33°.

The 16° 15′ intersection was the junction of the arch of an intercepting sewer, 7 ft. in diameter, with a segmental arch of 18 ft. of span with a radius of 12.125 ft.

I herewith send you a plan and section, Fig. 1, of the chamber or conical section, at Prestman St. and Addison Alley; also two photographs, Figs. 2 and 3, of a junction constructed in the intersection of Fremont Ave. and Penn St., showing the natural junction of the two arches. Fig. 2 shows the top and Fig 3 the under side of the work. The angle is 31° 11′. The main arch is a semi-ellipse of 18 ft. span with a rise of 5.2 ft. The arch of the smaller sewer is a semi-ellipse of 8 ft. span with a rise of 2.5 ft.

Those who have seen and criticised these junctions favor the latter mode of construction and consider that they are a success. You will notice in the photographs that there is very little covering over the arches. They have been constructed for several years and cars and heavy traffic constantly pass over them. It requires good judgment and experience in knowing just what material and where the Portland and natural cements should be used in the construction of these junctions.

Very respectfully,
Chas. P. Kahler, C. E.,
Assistant City Commissioner.

Baltimore, Md., March 14, 1896.

(We have received a letter from Mr. Ruhm regarding the circumstances which led up to his communication published in our issue of Feb. 6 and answered by various letters in our issue of March 12. Mr. Ruhm explains that he is not unfamiliar with bell-mouth intersections, and that he did not write for information to aid him in designing a sewer. Briefly stated, Mr. Ruhm was engineer of a company which had a sewer to construct in Nashville under plans and specifications with the preparation of which he had nothing to do. A sewer intersection was actually built under a design like that submitted by Mr. Ogden in our issue of March 12. The specifications said nothing regarding the length of time to be allowed before pulling the centers, and a sub-contractor pulled them when the work was 24 hours old. The intersection caved in, killing one man. It was afterwards rebuilt with no change except in bond. No one would go in to pull the centers and they remained in place for two months, when they were washed out by a large flow after a heavy rain.—Ed.)

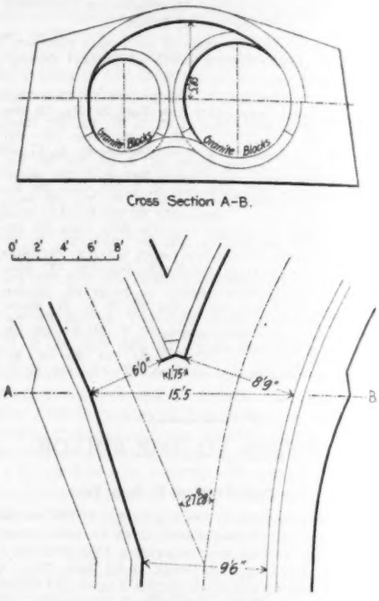


Fig. 1.—Plan and Section, Intersection of Prestman St. and Addison Alley Sewers, Baltimore, Md., Chas. P. Kahler, Assistant City Commissioner.

A RIGID CONNECTION FOR LATERAL BRACING OF A PIN-CONNECTED TRUSS.

In the ordinary style of construction of pin-connected deck bridges the lateral bracing consists very frequently of rods having bent loop ends which fit over the pins, and as it is almost impossible to keep all these rods tight the bracing is almost always rattling and noisy under traffic, while if it is set up tight it may throw a bending strain upon the pins. The accompanying cut represents an extremely stiff and rigid form of

Fig. 2.—View from Above.

Fig. 3.—Interior View.

FIGS. 2 AND 3.—INTERSECTION OF FREMONT AVE. AND PENN ST. SEWERS, BALTIMORE, MD.

connection, which makes a very substantial piece of work.

On the inner side of each post are riveted two ⅝-in. elbow or gusset plates, to which the lateral bracing of angle irons, ⅝ × 4 × 4 ins., are riveted, each end of each angle iron being secured by eight rivets. The bottom of the lower gusset is riveted between the two angle irons which form the transverse connections between the posts, while the top of the upper gusset is riveted to the lower flange of the heavy plate girder floor beams, thus making an exceptionally strong connection between the post and the floor beam. The details of construction are clearly shown.

The bridge on which this connection is used, as shown in the cut, is No. 13, on the Delaware Division of the New York, Lake Erie & Western R. R., crossing the Delaware River near Callicoon, and was built in 1891 by the Elmira Bridge Co., of Elmira, N. Y. It is 158 ft. 1½ ins. long, c. to c. of end pins, and the truss depth is 17 ft. c. to c. of pins. The chords and posts are of very heavy construction, and this, together with the stiff lateral bracing, makes a rigid structure, which produces no more noise or rattling under traffic than a riveted structure would produce.

SPECIFICATIONS FOR THE STATE HIGHWAYS OF MASSACHUSETTS.

We give herewith a somewhat full abstract of the specifications adopted by the Massachusetts Highway Commission governing the work to be carried out with its aid and under the supervision of its engineer. The work is to be done in accordance with these specifications and with the plans signed by the commissioners and the engineer.

The contractor is required to do all clearing and grubbing, excavation and embankment, leveling, grading, surfacing, masonry, culverts and fencing; to furnish all materials, implements and labor, to clear away all rubbish and to leave the work in a finished and neat condition.

Earthwork.—The roadbed shall be graded for the width of —— ft., true to the levels given, and in conformity with the plans, sections and profiles, the surface to be raised —— ins. higher in the center than at the sides, for its proper drainage. On each side shall be prepared ditches or gutters (with outlets for the water where directed by the Engineer) of such width and depth as the Engineer may direct.

All clay and spongy material shall be removed to a depth to be determined upon by the Engineer, and the space refilled with gravel or coarse stone. Gravel or stone to be paid for by the cubic yard, when obtained outside of the roadbed excavation.

Material of proper quality, excavated from the line of the road or from borrow-pits, approved by the Engineer for that purpose, shall be used for forming the roadbed, for building embankments, and generally for making all filling and grading that may be found necessary.

The top soil is to be removed from the surface of the road where necessary. All trees, stumps, and roots in the course of the work shall be grubbed up and removed.

The embankment shall be formed of successive layers of not more than 12 ins. in thickness, each layer to be thoroughly rolled by a roller weighing not less than two tons.

All surfaces and slopes in excavations, in the borrow-pits or on the embankments, shall be left with neat and even surfaces. All slopes in embankments to be covered with loam from the excavations when possible.

Rock Excavation.—Only such ledge as requires blasting for its removal, and boulders of one cubic yard or more in volume, will be estimated as rock excavation. No allowance for ledge excavation shall be made outside of or below the lines indicated on the sections.

Rubble Masonry (Dry).—This class of masonry will be used for culverts, except upon exposed faces, and for retaining walls.

It shall be composed of quarry stones, presenting good beds for material of this kind, of suitable sizes and shapes for the work, properly breaking joints, and with sufficient headers to make well-bonded work, spalls to be used only when absolutely needed for levelling up or pinning; large stones are to be used for foundation courses and for the heads and faces of culverts.

The covering stones of culverts are to be not less than 12 ins. thick, laid close together, with cracks thoroughly closed with pinners.

The ends of culverts shall be laid parallel to the center line of the broken stone. The walls shall be of coursed rubble, breaking joints at least 1 ft., and to have no "pinners" on the face, joints not to exceed 1 in. The wall is to be capped with coping stones 1 ft. thick, and at least 2 ft. wide.

Rubble Masonry (Laid in Cement).—All stone used in the work shall be free from structural defects. The mortar shall be made of 1 part of American cement and 2 parts of coarse, clean, sharp sand, free from loam and pebbles, mixed in such quantities as to insure its use very soon after mixing. Any mortar not used within three quarters of an hour after mixing with water shall be rejected.

The cement used must be made by manufacturers of established reputation, must be fresh, very finely ground, and put up in well-made casks. It will be subject to inspection and rigorous tests, and if found of improper quality must be immediately removed from the work. The contractor shall, at all times, keep in store, at the site of the work, a sufficient quantity of the cement to allow ample time for the tests to be made without delay to the work of construction.

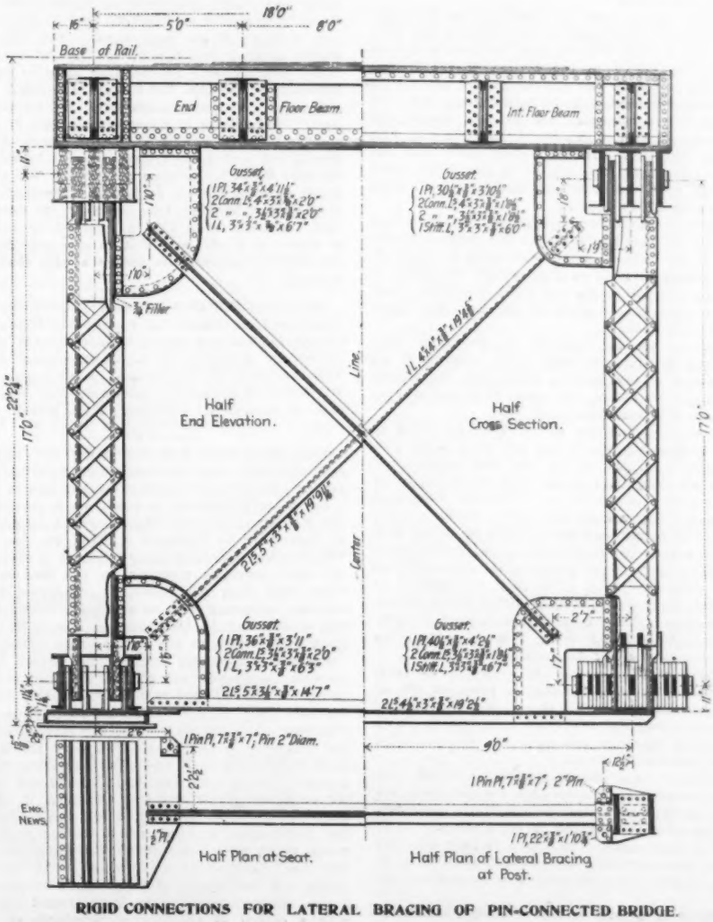
All cement must be so stored as to keep it dry, and each cask, as stored, must be raised several inches above the ground, by blocking or otherwise.

Fencing used as Guard Rails.—At culverts iron rods 1 in. square shall be used, set into the coping stone at least 4 ins.

Fencing shall be placed on the edges of embankments and at such other places along the road as the Engineer may deem necessary. The posts shall be of sound, straight chestnut or cedar, not less than 6 ins. diameter, spaced 8 ft. apart, squared at the butt, and set plumb in straight lines, 3 ft. into the ground, and 3½ ft. above the ground, and the back-filling thoroughly tamped. All bark shall be removed before setting. The top rails shall be 4 ins. square spruce, planed. The side rail shall be 2 × 6 ins. straight-grained spruce, planed, free from loose or unsound knots, and both top and side rail shall be notched into and securely fastened to the posts. All parts of exposed surface of the fence shall be painted with two coats of the best lead and linseed oil paints, of such color as the Engineer may direct.

Shaping Surface for Broken Stone.—Before the broken stone is spread, the roadbed shall be shaped to a true surface and rolled by a steam roller unless otherwise ordered. All depressions occurring must be filled and again rolled until the surface is smooth and hard.

Broken Stone. (To be used on roads with heavy traffic, or where, in the opinion of the Engineer, the stone is not of proper hardness).—On the roadbed, prepared as hereinbefore specified, the width of the broken stone shall be — ft. There shall be a layer of broken stones, not larger than 2½ nor smaller than ½ in. in their largest diameters, rolled to a thickness of 3 ins. The surface shall be left true and even, and conforming to the surface of the proposed finished roadway, and 3 ins. below the grade as shown on the profile. On this shall be laid a similar layer of broken stone, rolled to a thickness of 3 ins. in the middle, and 2 ins. on the sides. The whole surface shall then be rolled until the stone is thoroughly consolidated and left true and even, conforming to the cross-section and grade shown on plans. Screenings from the crusher that will pass through a ½-in. mesh shall then be laid on, watered and rolled until the mud shall flush to the surface. Care must be taken to lay on just enough of the screenings to cover the large stone. All rolling on the broken stone must be done by a steam roller of such weight and dimensions as shall be approved by the Engineer.



RIGID CONNECTIONS FOR LATERAL BRACING OF PIN-CONNECTED BRIDGE.

Broken Stone. (To be used on roads where the traffic is light, or where, in the opinion of the Engineer, the stone is sufficiently hard.)—On the roadbed, prepared as hereinbefore specified, the width of the broken stone shall be — ft. There shall be a layer of broken stone, not larger than 2½ ins. nor smaller than 1¼ ins. in their largest diameters, the same to be rolled to a thickness of — ins. in the middle, and — ins. on the sides of the roadway. The surface shall be left true and even and conforming to the surface of the proposed finished roadway, and 2 ins. below the grade as shown on the profile. There shall be laid on a layer of broken stones not larger than 1¼ ins. nor smaller than ½ in. in their largest diameter, to a depth of 2 ins. The whole surface shall then be rolled and treated as before specified.

Telford.—On the sub-grade a foundation shall be made of sound, hard stones 4 ins. to 10 ins. in width, and 6 to 20 ins. in length, and not less than 8 ins. in depth. They shall be placed by hand, vertically, on the broadest edges and lengthwise across the roadway, so as to form a close, firm pavement; they shall be bound by inserting and driving down, in all places where practicable, stones of proper size and shape to wedge them in their proper position; all projections of the foundations above grade shall be broken off by hand and driven into the spaces, and wedging stones shall be furnished and driven until the foundation shall be full to grade. The foundation shall then be thoroughly rolled; the sub-grade given will be parallel to the proposed finished grade, and — ins. below it.

Gravel Foundation.—In all places when it becomes necessary to remove the existing soil, or in places where

it shall be deemed necessary to secure a good foundation, suitable gravel shall be spread over the roadway to a depth directed by the Engineer; the same to be properly shaped and thoroughly rolled before placing any stone on same.

Vitrified Clay Pipe (for Culverts).—All pipes shall be first quality, salt glazed, free from blisters and cracks, straight and round, and laid true to the lines and grades furnished by the Engineer. Nothing but selected fine material, free from large stones, shall be placed under or around the pipe, and all material placed under and about the pipe shall be thoroughly tamped in place by a thin iron tamping bar. All joints shall be made of first-quality American cement mortar, carefully filled in all around the pipe.

Drains.—The trench shall be excavated not less than 2½ ft. below sub-grade, and not less than 12 ins. wide at bottom and 15 ins. wide at top. At least 3 ins. of gravel shall be placed in the bottom of the trench. On this shall be placed salt glazed, vitrified drain pipe, — ins. in diameter, with bell and spigot joints laid with open joints unless otherwise ordered; the trench will then be filled to a point 6 ins. above the drain pipe with gravel that will pass through a 1-in. mesh and not through a ¼-in. mesh; the balance of the trench shall be filled with stone which will go through a 3-in. mesh and not through a 1-in. mesh.

Finishing Between Limits.—All stones less than half a cubic yard in size, appearing on the surface within the limits of the location of the road, shall be removed. All rubbish shall be removed from within the limits of the location, and all brush and trees (excepting such as shall be specially exempted by the Engineer) shall be grubbed up and burned.

Where directed by the Engineer the contractor shall plow, harrow, brush, and seed with grass seed all unused portions of the location other than the slopes, and shall cover all slopes with loam from the excavations and sow the same with grass seed.

Cobble-Stone Gutters.—The stones shall be equal to good hard field stone, not to lay less than 4 sq. yds. nor more than 6 sq. yds. to the ton. The contractor is to excavate for the gutters to the depth of 12 ins. below the finished surface of the gutters. A gravel foundation shall be rammed into a solid layer 4 ins. thick. A layer of bedding sand or screened gravel shall be spread over the gravel of a sufficient depth to bring the gutter stones that are bedded in it to the proper grade after they are thoroughly rammed. Each stone shall be rammed to an unyielding foundation and the surface left true and even. The surface shall be covered with sand of sufficient depth to fill all interstices. Selected large stone shall be laid true to a line on the sides and center.

Setting Stone Bounds.—Stone monuments 6 ft. long, to be furnished by the Commission, shall be set at such points and at such depths as may be designated by the Engineer. When the excavation is in spongy earth, gravel, or sand must be furnished by the contractor to be placed about the stone.

General Clauses.—All persons employed in the performance of manual labor under this contract shall not be required to work more than nine hours in each day, and nine hours shall constitute a day's work.

The work is to be commenced within 15 days after the execution of this contract and be diligently prosecuted to completion, in such order as may be prescribed by the Engineer.

The contractor is to furnish, free of charge, such temporary structures as may be necessary for maintaining points and lines given by the Engineer for the building of the work, and is to give said Engineer such facilities and materials for giving said lines and points as he may require; and the Engineer's marks must be carefully preserved.

THE WIDENING OF THE ERIE CANAL LOCKS, for the passage of torpedo boats to the Lakes, is proposed in a bill submitted to Congress by Representative Mahany. The bill appropriates $2,000,000 to widen one set of the double locks about 5 ft.; State Engineer, C. W. Adams, however, deems the scheme impracticable on the lines proposed. He estimates that to increase the locks to 225 ft. long by 26 ft. wide and 8 ft. deep on miter-sill would cost about $13,000,000. Mr. Adams also is opposed to having the national government assume any responsibility or control in connection with the New York State canals. He fears that this control would increase until the West and Northwest representatives in Congress would soon run the whole canal on terms more profitable to them than to the State of New York. He thinks New York is big and rich enough to build, widen and maintain her own canals—and to control them absolutely.

THE SUPER-IMPOSED TURRET EXPERIMENTS, lately conducted at Indian Head, demonstrate that the shock from the guns in the upper turret will not disable the men in the sighting hood of the one below, as was feared. To test this latter theory, a hole was dug in the ground in front of the 8-in. gun and this hole was surmounted by a sighting-hood of service dimensions and thickness. As in service, the muzzle of the 8-in. gun was 15 ft. outboard of the hood. Four service charges were fired and the effect of the blast was watched by officers stationed under the hood. The report was: No special discomfort from the shock, and the shock was not so great as to interfere with deliberate and accurate work. The effect was about the same as if the men had been at the breech of the gun instead of under the muzzle. The test was very satisfactory and will do much towards settling the present discussion as to the advisability of placing the 8-in. above the 13-in. guns in the turrets of the new battleships.

THE PORT ROYAL DRY DOCK is officially reported upon, to Commodore Matthews, Chief of the Bureau of Yards and Docks, practically as follows: The battleship "Iowa" was docked on March 27, with 15 ins. of clearance over the sill of the caisson-gate. The ship took the blocks squarely and evenly, and careful measurements made, after pumping out the dock, show no signs of displacement or settling. The leakage is "normal, the drainage pump controlling it perfectly, not running all the time." The caisson is a perfect and tight fit, and Commander C. H. Rockwell, U. S. N., Commandant of the Port Royal Station, says that so far as he can discover, the dock fulfils the purpose for which it was constructed. Other accounts are not so favorable; complaint is made of the small working space between the dock and the hull, especially when this is curtailed by the presence of water. It is also said that an appropriation of $360,000 will be necessary to dredge a safe channel up to the dock.

THE CONNECTICUT VALLEY HIGHWAY ASSOCIATION has been formed at Springfield, Mass., by road superintendents and others, to advance the good roads movement. President, W. L. Dickinson, of Springfield; Vice-Presidents, C. E. Crehore, of Chicopee, and Enos W. Boise, of Blandford; Secretary, City Engineer Slocum, of Springfield; Treasurer, T. B. Moseley, of Westfield.

THE FIFTIETH ANNIVERSARY OF THE PENNsylvania R. R. will be celebrated April 13, the road having been first incorporated on that date in 1843, with a capital of $7,500,000, to run from a connection with the Harrisburg, Portsmouth, Mt. Joy & Lancaster R. R. at Harrisburg to Pittsburg or Erie, Pa. Mr. J. Edgar Thomson was appointed Chief Engineer in 1847. On July 16, 1847, contracts were let for the first construction work west from Harrisburg, and the first division of the road, extending from Harrisburg to the Portage R. R., was opened Sept. 15, 1850, making a continuous rail line from Philadelphia to the Portage road. The line from Johnstown to Pittsburg was completed in 1852. Connection between the Eastern and Western divisions was made by using the Portage road over the mountains, and on Dec. 10, 1852, cars were run through from Philadelphia to Pittsburg. The company's road over the mountains was not completed until Feb. 15, 1854, when trains were run from Philadelphia to Pittsburg without using the inclined planes. The State on Aug. 1, 1857, sold and transferred its main line (Philadelphia & Columbia R. R.) to the Pennsylvania R. R. Co., and in 1861 the company leased the Harrisburg & Lancaster R. R. for a term of 999 years, which gave it a through line under its own control from Philadelphia to Pittsburg. The various lines owned and leased west of Pittsburg, were placed under a new corporation called the Pennsylvania Co. in 1871, with a capital of $12,000,000, two-thirds of which is owned by the Pennsylvania R. R. Co. The two great corporations now own and control 8,882 miles of line.

RAILWAY BUILDING IN RUSSIA is being vigorously pushed just now, says "Le Genie Civile." The activity is general. The Siberian railway is completed over the first section of 150 miles, between Jekaterinburg and Tscheljabinsk, and building of bridges, stations, etc., is well advanced. Since last October trains have been run between these two places by using temporary bridges over the streams. On a new railway, 397 miles long, between Vologda and Archangelsk, 7,000 men are now at work in a region practically uninhabited. In the province of Archangelsk there is only one village of 15 houses on 154 miles of the line. The line crosses a peat-moss 19¼ miles wide, over which an earthen embankment is being built with much trouble and expense. The Russian government hopes to people this deserted country in time, and towards this end it establishes at each station a hotel, stores, grain elevators and an establishment for the preparation of fish, the latter forming the chief food supply of the people of this region, the Samojedes. Some French engineers are building a railway, 175½ miles long, extending from Prochladnaja, a station on the Vladikaukas railway, just north of the Caucasus, to Poti, on the Black Sea, says "Le Genie Civile." But as the Caucasus range of mountains lies between the points named, this statement must be taken for what it is worth. The route referred to would lie on the line of the Dareel Pass, with a summit 8,000 ft. above the sea and such a road would involve an enormous expenditure of money. Before the end of 1898, the Russian government expects to complete the Moscow-Kiew Woronege system, on extensions aggregating 420 miles of railway. Among the important branches proposed is one connecting Moscow with Brjansk, an important iron center. On the Rjasan-Oural line extensions amounting to about 370 miles are in progress. Other roads are being pushed, intended to ultimately connect Russia proper with Samarkand, Margelau and Teheran; one line will unite the fortress of Kars with Tiflis on the Trans-Caucasian railway. The Minister of Finance proposes to appropriate for the next 40 years, an annual credit of 40,000,000 francs to be used by provinces and towns in the extension of secondary lines of railway. He estimates that this would be sufficient for the construction of about 20,000 miles of railway, used in connection with local contributions.

THE FOUNDATIONS FOR A 4,500,000-CU.-FT. GASholder for the New York Mutual Gas Light Co. possess some points of interest. The holder is to be located near salt water and will be entirely above ground. The excavation for the foundations was 196 ft. in diameter. Piles 20 to 40 ft. in length were driven 3 ft. c. to c. over this whole area, 4,100 having been put down. These were cut off 3 ft. below tidewater and capped with 12 × 12-in. yellow pine. On this was laid a close flooring of 6 × 12-in. yellow pine, the spaces between the caps having first been filled with broken brick and sand. Surmounting this is a wall 6 ft. thick at the bottom, 5 ft. at the top, battered on the outside and 10 ft. high. Within the enclosure 11,000 cu. yds. of washed gravel was rolled, tamped and flushed in 6-in. layers, reaching within 1 ft. of the top of the wall. The foundation was completed by 1 ft. of hydraulic cement concrete, finished to a smooth surface with hydraulic cement. The total weight to be sustained by the foundations is about 65,000 tons. The above information is abstracted from the "American Gas Light Journal."

THE NEW ROLLING MILL OF THE PITTSBURGH REDUCTION CO., NEW KENSINGTON, PA.

In our issue of March 26, in an article on the New Water Power Development below Niagara Falls, we mentioned the new works of the Pittsburg Reduction Co. for the production of aluminum. The first, or experimental works of this company was established in Pittsburg in 1888. After several enlargements it was removed to New Kensington, Pa., in 1891. In 1894 a new plant was built at Niagara Falls to utilize electric current furnished by the Niagara Falls Power Co., the New Kensington works being retained as a branch establishment for rolling, finishing, etc. Still a fourth works is now in course of erection below the Falls, as described in the article above mentioned, which is to be run in conjunction with the upper works. The New Kensington works are also to be enlarged by the erection of a new rolling mill for rolling sheets and plates. The following description of this mill has been furnished us by the company:

The rolls are 84 ins. wide. The bedplates weigh 500 lbs. per ft., or 1,000 lbs. per ft. of train. The roll housings have a secetion 14 × 20 ins., and weigh each 22,000 lbs. The double spiral pinions are 29 ins. diameter, with 29 ins. face of teeth and 33 ins. face, including the shrouds; the necks are 18 ins. diameter. There is one stand of chilled rolls for finishing and one stand of sand rolls for roughing. The chilled rolls have necks 16 ins. long, 20 ins. diameter and couplings 9 ins. long. 16 × 10 × 6 ins. The bodies of the finishing rolls are polished. The bottom brasses are 2 ins. thick, lined with anti-friction metal and encircle one-third of the necks. The housing screws are 8 ins. diameter, made of forged steel. The screw boxes are of wrought iron and held in place by lock-nuts, which rest upon the top of the housings. The crab spindle is cast iron. The roll riders are of wrought iron, provided with pressure plates, which can be removed when necessary. The foundation bolts are 9 ft. long, 2¼ ins. diameter, two rows of which are put in each bedplate. The top finishing roll is driven by a device operated from the bottom roll. The screws on the roughening rolls are manipulated by a system of pulleys, which are driven by the top roll.

The hydraulic table is designed to operate at a pressure of 140 lbs. Attached to the table is a device which prevents the ingots from entering the rolls until the table is in position to receive it. The total weight of all material is 341,000 lbs.

The engine is a standard, left-hand, forward-running Porter-Allen automatic engine, built by the Southwark Foundry & Machine Co., of Philadelphia, with cylinder 32 ins. diameter × 48 ins. stroke of piston, designed to run at 112 revolu-

Tests of Paving Brick at Williamsport, Pa.

Kind.	Abrasion Test. 30 mins. in rattler 24 in. diameter making 27 revolutions per min. Weight. Before oz.	After oz.	Loss oz.	Rank.	Loss in terms of granite.	Absorption Test. (44 hours in water.) Weight before oz.	Weight after oz.	Gain oz.	Rank.	Summary. Per cent of Gain in Absorption.	Per cent. of Loss in Abrasion.	Ave.	Rank.
Granite	173.56	168.33	5.23	..	1.00	168.33	169.92	1.59	..	.94	3.0	1.97	..
Nelsonville, block	162.93	145.75	17.18	1	3.52	145.75	146.60	.85	1	.58	10.55	5.56	1
Metropolitan, block	153.75	136.94	16.81	2	3.65	136.94	138.12	1.18	2	.86	10.95	5.90	2
Clearfield C. Co., bl'k.	135.69	120.12	15.57	3	3.83	120.12	122.37	2.25	8	1.87	11.50	6.68	4
Mack Shale, bl'k	140.50	123.37	17.13	4	4.07	123.37	124.50	1.13	4	.92	12.20	6.56	3
D. P. Guise	121.56	105.97	15.59	5	4.27	105.97	107.59	1.62	7	1.53	12.80	7.16	5
Athens	139.31	120.18	19.13	6	4.57	120.18	121.87	1.69	6	1.41	13.70	7.55	6
Mack block, F. C.	145.78	125.72	20.06	7	4.60	125.72	131.40	5.68	14	4.53	13.80	9.16	7
Cle'rf'ld C. Co. F. C.	110.62	90.56	20.06	8	6.05	90.56	91.43	.87	5	.96	18.10	9.53	8
Park Fire Clay, rep.	104.93	86.75	18.18	9	6.10	86.75	89.47	2.72	11	3.14	18.30	10.72	10
Townsend bl'k, shale	148.12	120.81	27.31	10	6.13	120.81	121.90	1.09	3	.90	18.40	9.65	9
Cl'rf'ld C. Co., shale	108.87	87.25	21.62	11	6.05	87.25	90.06	2.81	12	3.22	19.90	11.56	13
Park Fire Clay, st'd.	104.84	83.93	20.91	12	6.68	83.93	85.53	1.60	9	1.90	20.00	10.95	11
Mack Rep., F. C.	107.00	85.50	21.50	13	6.70	85.50	87.78	2.28	10	2.66	20.10	11.38	12
Mill Hall	107.84	69.56	38.28	14	11.80	69.56	72.62	3.06	13	4.40	35.50	19.95	14

tions or less per minute, with 140 lbs. initial steam pressure. The flywheel is 20 ft. in diameter, weighing 60,000 lbs., and is made in halves.

On our receiving the above description from the Pittsburg Reduction Co., we wrote them, asking the following questions:

1. Why is a 2-high mill used instead of a 3-high?

2. Why is the mill built at New Kensington instead of Niagara Falls, where the company can obtain cheap electric power. The following is their reply:

Sir: Our roll-train is 2-high. Neither copper, brass, nor aluminum is rolled on 3-high trains; the reason being that as much as possible of the work has to be done on the roughing rolls, only leaving a very small amount of reduction to be carried out on the finishing train. The roughing rolls, therefore, have to be in pretty good trim all the time; and it is found impossible to have the rolls ground satisfactorily so that the middle roll will fit both the upper and lower roll at the same time sufficiently accurate for finishing work on aluminum. For rough steel work, the 3-high train is undoubtedly an advantage; but where the sheet is to be left with a fine finish, it is found impracticable to dress the middle roll so that it will give good finished material from both the upper and lower rolls.

Again, in rolling very thin sheet, the metal often buckles; and to prevent this buckling, the rolls have to be dressed by the skilled roller so that the buckle is prevented. This operation is done by putting powdered emery, with some oil, upon the end of a stick and grinding the rolls in this way to the propper finish.

All the rolls are chilled rolls; no sand rolls are used in rolling aluminum. It may be that in the future when we will be, as we expect to be, making aluminum in heavy sections, in the same way that heavy sections are made in steel for structural work, where a fine finish is not required, a 3-high mill will be advisable; but at present it is impracticable with the demands being made for wide sheet to be rolled as low as No. 24 to No. 26 gage with the finish required for pure aluminum. You ask the question as to why we do not put this rolling mill at Niagara Falls and drive by electric power. The reasons are these:

1. We have not thus far any knowledge of any electric motor which has given satisfaction for running a rolling mill. The loads applied to an engine doing ordinary grades of work are very different from the regular loads of a rolling mill, especially where the metal is practically cold-rolled, as it is in a large amount of the work we have.

2. The land at Niagara Falls is costing with the Niagara Falls Power Co. at least $1,000 an acre per annum rent; and the Niagara Falls Hydraulic Power & Mfg. Co. have no land near their plant available for a large and extended rolling mill plant.

3. The amount of power actually used in rolling is not a steady and regular one, and we would have to pay for the maximum power we wanted to use, when a large portion of the time no power at all would be required. For this purpose the difference between our rate of $25 per horse-power for the power on the shaft of engines at our works at New Kensington and the rate of, say, $12 or $15 per horse-power at Niagara can thus be expended by us to good advantage.

4. Taxes at Niagara will undoubtedly be an important and high factor at the growing town of Niagara, which will require many improvements.

5. We have our own plant already located at New Kensington and 2,000 HP. of steam plant in existence there, which we shall soon not use for the manufacture of aluminum but will use for our rolling mill plant.

6. A rolling mill can be much more economically run in the Pittsburgh district than in the Niagara district, due to the larger field of skilled workmen, such as rollers and the like, to be drawn from in an essentially metallurgical district as Pittsburgh as against Niagara Falls.

This same argument applies to foundries for casting rolls and machine shops for doing work of this character.

Trusting this information will be satisfactory to you, we remain,

Very respectfully,

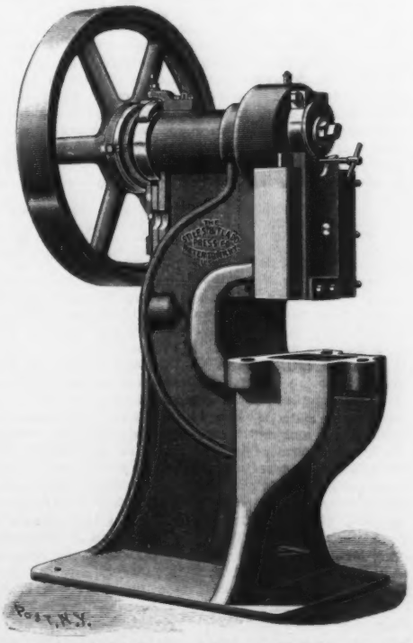
Alfred E. Hunt,
President The Pittsburg Reduction Co.

TESTS OF PAVING BRICK AT WILLIAMSPORT.

We have received from Mr. George D. Snyder, City Engineer of Williamsport, Pa., the results of tests of brick submitted in connection with bids for 7,450 sq. yds. of brick paving received in March last. We have rearranged and condensed the figures in the table given above.

A NEW PUNCHING PRESS.

We illustrate herewith a punching press, which is made in eleven sizes by the Stiles & Fladd Press Co., of Watertown, N. Y., a corporation which was formed last year. Mr. E. S. Stiles, the Treasurer and General Manager, is well known from his long connection with the old Stiles & Parker



A New Punching Press. Built by The Stiles & Fladd Press Co., Watertown, N. Y.

Press Co., of Middletown, Conn., which consolidated with the E. W. Bliss Co. some years ago. Mr. Fladd was also with the old company, and has been engaged in the design and manufacture of presses for many years. There is no great novelty in the design of the press here shown, and its chief claim is for excellence of workmanship and material.

A special mixture of iron, showing great strength, is used in the castings, which is continually tested and retained to an established standard. Every part on which wear occurs is scraped to an exact fit, thereby providing a perfect bearing surface. The ways, or guides, of the slide are exceptionally long. The clutch is one that has been perfected and recently patented by the inventor of the original Stiles clutch and Stiles press. Among the special features are the ability to run the press in either direction equally well, three points of contact in the wheel causing the clutch to be practically instantaneous, and the power vested in the operator to make at will a whole revolution or only a part as he may desire, thereby preventing accidents. The clutch can be used to back out a punch that may become stuck in the die.

These presses are manufactured in six sizes, weighing from 500 to 7,500 lbs., as "fly presses," and in five sizes, ranging in weight from 1,200 to 8,000 lbs., as geared presses. The patterns are so constructed that a great variety of modifications and changes can be made to adapt them to special work and to tools of any make.

BOOK REVIEWS.

ELECTRICITY UP TO DATE FOR LIGHT, POWER AND TRACTION.—By John B. Verity, M. Inst. C. E. Frederick Warne & Co., London and New York 1896. 12mo.; pp. 237; $1.

We learn from the preface to this little work that it is now in its fifth edition, and that 20,000 copies of the work have found their way into circulation. This large circulation can only be explained by the fact that the great general public has an insatiable appetite for anything and everything that is written on the subject of electricity, especially if it is low priced, for the book itself is a rather weak production. It is written in a semi-popular, fragmentary style, and spreads itself out thin over the vast range of the subject of electrical currents and their uses for light, power, traction, and even "electrocution." The book is of no use to an engineer, and we carnot even recommend it to the non-technical reader.

MODERN STONE-CUTTING AND MASONRY.—With Special Reference to the Making of Working Drawings. By John S. Siebert, C. E., and Frederic Child Biggin, B. S., Instructor in Architecture, Lehigh University. New York: John Wiley & Sons, 8vo.; pp. 47; illustrations. $1.50.

The purpose of the authors in issuing this book is to supply an "up-to-date" treatise on stone-cutting, and to use only such material as has a direct application to engineering and to architectural work in this country. The first chapters describe and illustrate the tools used, classify stone-work according to its finish, define the parts of a masonry structure and classify masonry. The final pages treat of the buttress, arches and intersecting arches, arch-culverts, railway bridge masonry, canal-lock masonry and architectural stone-work. The right-arch with a skew-face is substituted for the oblique arch proper, now so rarely used. The text and illustrations are plain, so far as they go; but both might have been farther extended without detriment to the treatise, and this especially applies to canal-lock and bridge-masonry. A chapter upon the bond in brick masonry and especially in brick arches of large span would have been a useful addition.

SHOP KINKS AND MACHINE-SHOP CHAT.—A series of over five hundred practical paragraphs in familiar language, showing special ways of doing work better, more cheaply and more rapidly than usual. By Robert Grimshaw, M. E., etc. With 222 engravings. New York: Norman W. Henley & Co. 12mo.; cloth; pp. 393. $2.50.

This book is chiefly a reprint of numerous shop "kinks," etc., which have been contributed from time to time by the author to the columns of different mechanical papers. It contains a great deal of information which every machinist should know as part of his trade, much of it written in an easy slip-shod sort of a way, which may be suitable for machine-shop "chat," but is ill adapted for instruction. Here are a couple of examples of his style:

Chilled Castings: You seem to be laboring under a bad case of imperfect chill, over there in the foundry. If you will try using a little spiegeleisen you will find that you will get more chill than you now have, and if what you try does not give enough you can try until you get what you want. Calculating Horse-Power: There is no use in going up stairs for the privilege of coming down, either in walking, language or calculation. When figuring up horse-power it is usually necessary to get at the area of the piston-head by squaring the diameter and multiplying the square by 0.7854, and then it is necessary to divide by 33,000.

THE CHEMISTRY OF GAS MANUFACTURE.—A Practical Handbook on the Production, Purification and Testing of Illuminating Gas, and the Assay of the Bye-Products of Gas Manufacture. For the use of Students, Chemists and Gas Engineers. By W. J. Atkinson Butterfield, M. A., F. C. S., Head Chemist, Gas Works, Beckton, London. With numerous illustrations. London: Charles Griffin & Co.; Philadelphia: J. B. Lippincott Co. 1896. 12mo.; pp. 375; $3.50.

The sub-title of this work expresses its scope more correctly than the principal title. It is far more than a treatise on gas chemistry, for it treats with considerable detail of the mechanical processes of gas manufacture,

and also of photometry. The chapter headings are: The Raw Materials of Gas Manufacture; Coal Gas; Carburetted Water Gas; Oil Gas; Enriching by Light Oils; Details of the Manufacture and Schemes for Making and Enriching Gas; Gas Analysis; Photometry; The Applications of Gas; Bye-Products. A very full alphabetical index is included. The method of treatment of the several branches of the subject is excellent, and the book is a welcome addition to the literature of gas manufacture. It is thoroughly modern, even treating of such recent innovations as calcium, carbide and acetylene. The opinion of the author on the value of acetylene as an enriching agent and as a commercial product is decidedly unfavorable. It would seem, he says, extremely improbable that under present conditions acetylene will ever come into comon use as a carburetting agent. We notice a slight error of statement concerning the chemical constitution of coal. The author states that oxygen varies for the most part in direct ratio with the hydrogen. This is far from being true of American bituminous coal, in which with approximately constant hydrogen, oxygen varies greatly with the district in which the coal is found.

THE WATER SUPPLY OF THE CITY OF NEW YORK, 1658-1895.—By Edward Wegmann, C. E., author of "The Design and Construction of Masonry Dams." New York: John Wiley & Sons. London: Chapman & Hall, Limited. 4to.; pp. xi., 316; 148 plates and 73 figures in the text. $10.

This is a comprehensive historical and descriptive work on the water supply of the largest city in the New World. The author has been connected with the new Croton aqueduct and allied reservoir construction since its inception and has had access to all available sources of information regarding both the old and new aqueduct and the construction carried out in the period between the two.

The early settlement and water supply of New York is sketched, and the various attempts and plans prior to the final adoption of the Croton as a source are set forth. The old aqueduct is then described, after which many improvements subsequently made are taken up. Naturally a large part of the volume is devoted to the new Croton aqueduct and dam. Many of the illustrations relating to this work are reproduced from the reports of the Croton Aqueduct Commission, or the originals there used, and those reports are also drawn upon for the text, but they cannot now be obtained without great difficulty, so that there has been no duplication of matter already available to those who are not so fortunate as to possess the volumes named.

Appendix I. describes the machinery used for the new aqueduct and also the great freshet of Jan. 3, 1841, and gives biographical sketches of engineers connected with the water supply of New York city.

Appendix II. gives the general form of contract used by the Aqueduct Commission, specifications for various kinds of work, rules and regulations of the State Board of Health for the protection of the purity of the Croton water supply, and a large amount of tabular matter relating to the principal contracts for the aqueduct, wages paid, contract prices, machinery used, progress of the work, rainfall in the Croton district and other matters.

The typography of the book is excellent, most of the illustrations are good while some are fine, and the binding is handsome. No other large city can boast of so elaborate a description of its water-works as Mr. Wegmann has written for New York.

COMPUTATION RULES AND LOGARITHMS.—With Tables of other Useful Functions. By Silas W. Holman, Professor of Physics at the Massachusetts Institute of Technology. New York: Macmillan & Co. 8vo.; cloth; pp. 73. $1.00.

The object of this book is to save labor in computations. The author believes that one-half of the time expended in computations is wasted through the use of an excessive number of places of figures and through failure to use logarithms. He also believes that there is a great saving of time in the employment of four-place instead of six or seven-place logarithms, the work being doubled or trebled by the use of six places instead of four. Simple rules are given to enable one to answer for himself the question: How many places of figures ought I to use in this computation?; together with an explanation of the use of the notation by the powers of ten and instructions as to the use of tables. The tables are: Logarithms, anti-logarithms and cologarithms, four place; logarithms, five place; squares, square roots, reciprocals, slide-wire ratios, natural and logarithmic sines, cosines, tangents and cotangents, all to four places; and logarithmic sines, cosines, tangents and cotangents, five places.

The collection of tables is designed to contain all the mathematical tables ordinarily required in practical work, in engineering and by students of physics, chemistry and engineering for work of any grade not requiring an accuracy greater than that in which an error of 0.0005 is the maximum permissible. Numerous examples showing the use of the author's rules are given, and a few pages are devoted to the subject of physical constants, giving the most recent values. The value of the mechanical equivalent of heat, expressed in foot pounds, equivalent to 1 British thermal unit is given as 778.8, with an uncertainty of only 1-20%. The persistence with which the old value 772 is adhered to in practice, the author holds is due largely to the flagrant negligence of authors of text-books, both of physics and engineering.

We heartily commend this book to engineers who have occasion to do much arithmetical computation, and especially to engineering students. The frequent use of this book and practice in numerical computations with its aid will prove a good antidote to the tendency which is now apparent to such an extensive use of the slide rule, that facility in arithmetical calculation is apt to be lost.

STEAM VESSELS AND MARINE ENGINES.—By G. Foster Howell. Being descriptions and illustrations of some of the principal Steamships, Steamboats, Steam Yachts and Tugs built in the United States during the past five years, together with regular and special designs of Compound, Triple and Quadruple-Expansion Yacht and Marine Engines, etc. With a chapter on Sailing Ships and Schooner Yachts. Published by "The American Shipbuilder," 7 Coenties Slip, New York. Large 4to.; paper boards, leather back; pp. 184. $5.00.

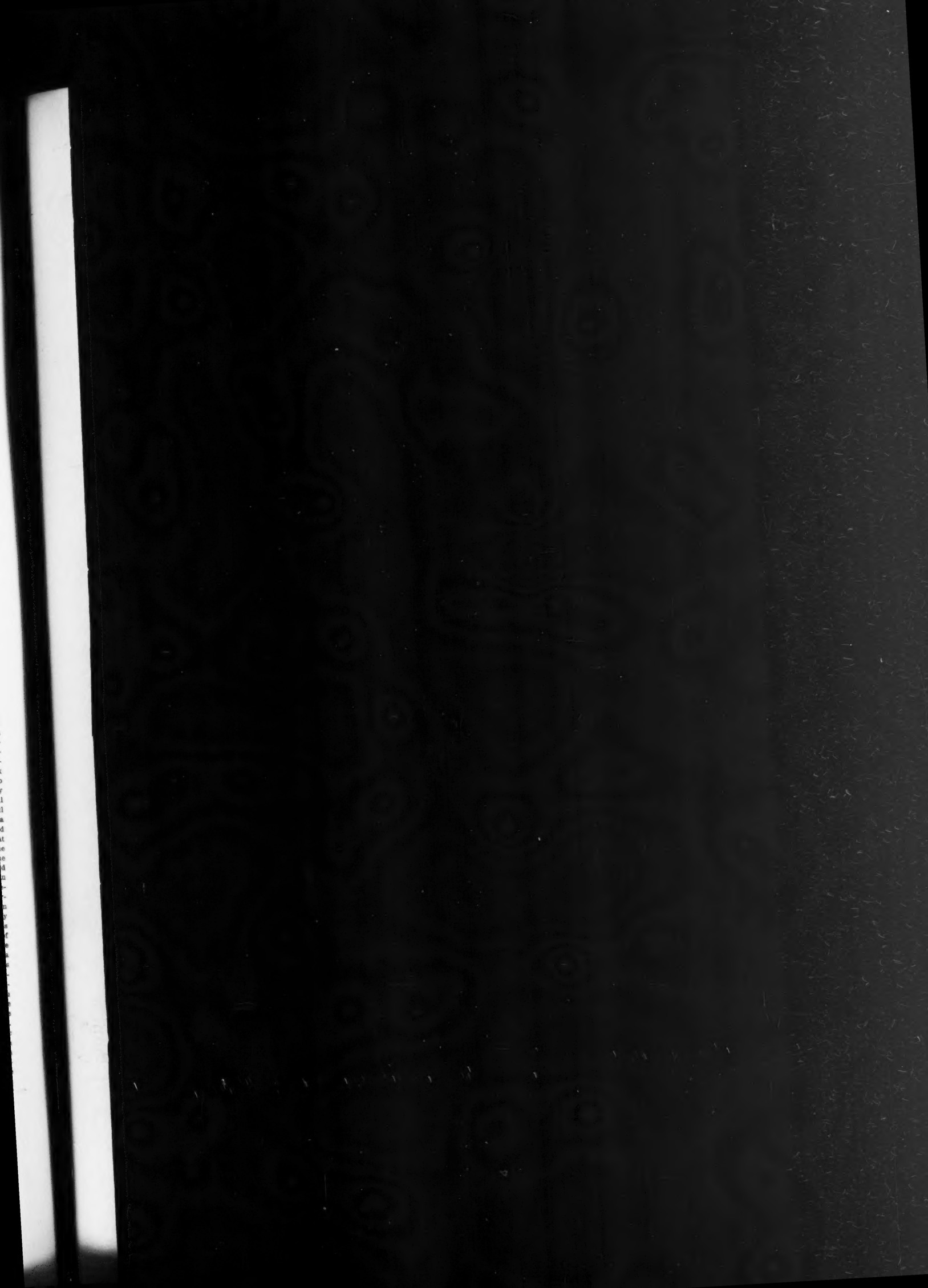
According to the preface the object of this book is to provide naval architects, shipbuilders and engineers with a work of reference. No book of this particular kind showing illustrations of modern American marine engines has ever been published in the United States. For the most part the work is merely a reprint of articles and illustrations that have previously appeared in various marine and mechanical journals in the United States and Great Britain.

Whenever a new steamship or sailing vessel is built, some marine or naval journal is apt to "write up" a description of it, illustrated with a photograph of the vessel as she appears when afloat, together with such views or drawings as can be obtained from the builders. The illustrations appear in the several journals in every form of the engravers' art, chiefly half-tone plates of various degrees of merit, The descriptions are also of a like varied character. Some are furnished by the builders, others by engineering writers employed by the journal, and still others by the non-technical but otherwise intelligent newspaper reporter. At the time these articles are published, they have more or less interest to the readers, some of them are clipped out and preserved for future reference, a few readers preserve and bind the journals in which they appear, but generally they are destroyed and forgotten. Mr. Howell has now done the work of collecting together a great number of these articles, and has reprinted them in book form with all their variety of literary and artistic merit, or lack of it. He has also made the work into something of a photograph album, giving 16 pages of half-tone reproductions of photographs of well-known shipbuilders and marine engineers, some of them so wretchedly poor as to be really caricatures. The shape of the book is inconvenient for most book-shelves, 13 x 11 ins. The book has a white board cover easily soiled, and the front cover is disfigured by a sprawling advertisement. There will no doubt be a number of people who will highly appreciate this book, and to them it map prove useful and entertaining, but in our own opinion it is engineering literature of a very poor sort.

ROADS AND PAVEMENTS IN FRANCE.—By Alfred Perkins Rockwell, A. M., Ph. B., formerly Professor of Mining at the Sheffield Scientific School and at the Massachusetts Institute of Technology. New York; John Wiley & Sons. 12mo.; 107 pp. $1.25.

The author has here gathered together, partly from personal observations, but mainly from standard publications and official documents of the French government, a mass of very useful matter connected with highway construction and maintenance in France. The first part of the treatise is general in its character, discussing gradients, materials and the several types of road construction, with and without foundations and in varying soils, the binding material, and the convexity of the roadway. Maintenance and repairs are separately handled, and the system is described as now prevailing in France, with percentages of cost of the various processes. Typical cross-sections of French highways are shown; tree-planting is described and such items connected with the general cost of construction of roads are stated as can be given when unaccompanied by a full detail of controling conditions. As deduced from the reports of the Minister of the Interior, for 1881-1886, the average cost of nearly 26,000 miles of macadamized road, of which over 17,000 miles were ordinary local roads, was as follows: Main highways, $2,926 per mile; secondary highways, $2,309 per mile, and ordinary local roads, $2,036 per mile. These figures include the cost of the road proper and the grading and right-of-way; but do not include the cost of bridges, culverts and other structures. The range in price is very great, being only $800 per mile in some Departments and as much as $5,600 and $7,200 per mile in others. The cost of maintenance of the national roads of France was not obtainable by the author. The pavements of Paris form a separate chapter, and under this head is set forth the full staff in charge and the list of public work over which the Engineer-in-Chief has control. All of the Paris pavements, except a portion of the block-stone paving, are laid on concrete foundations. The total area of Paris street pavements on Jan. 1, 1894, was 10,554,520 sq. yds., and the percentages of kinds of pavement were as follows: Block-stone, 71.5%; macadam, 16.3%; asphalt, 3.8%, and wood, 8.4%. Asphalt pavements date from 1855 and the first wood pavements were laid in 1881; but the tendency of to-day is to substitute wood or asphalt for stone and macadam, with wood as the present favorite. The method of laying and repairing the several classes of pavement is gone into with considerable detail, as is the method of street sweeping and watering.

THE ELECTRICAL TRANSMISSION OF ENERGY.—A Manual for the design of Electrical Circuits. By Arthur Vaughan Abbott, C. E., Chief Engineer Chicago Telephone Co., etc. With nine folding plates. New York: D. Van Nostrand Co. Cloth, 8vo.; pp. 586. $4.50.

According to the preface this work has been prepared chiefly from the aspect of the author's experience and is an endeavor to collect and arrange in an accessible and convenient form the data necessary to the scientific designing and proportioning of electrical circuits. No attempt has been made to describe any central station machinery. All matter obsolete or antiquated has been rejected and only such is presented as seems to be fully warranted by the present state of the art. Wherever possible the lines along which future practice is likely to lie have been indicated.

In the introductory chapter a very brief statement is given defining series, parallel and indirect distribution, then follows a chapter on the properties of uric, including uric specifications. Aerial and underground circuit construction and electrical instruments are then treated of in three chapters, covering nearly 200 pages. This matter is all thoroughly practical, and fully illustrated, showing all the usual forms of poles, cables, insulators, conduits, electrical testing apparatus, etc., and is especially valuable for the constructing engineer. The remainder of the work appeals more particularly to the designing electrician, and is to a considerable extent, as is necessary, theoretical and mathematical. Chapter VI. treats of electrical measurements, the location of faults, etc. It is very full, treating of alternating and polyphase as well as of continuous currents, and gives especial directions for measurement of currents on electric railways. Chapters VII. and VIII. treat of conductors for continuous and alternating currents, chapters IX., X. and XI. of series and parallel distribution, and of miscellaneous methods, inlucding motor transformers, polyphase system, long distance transmission, etc. The last chapter is devoted to the cost of production and distribution and is largely statistical, giving data from numerous sources, together with rules for estimating cost of future installations. The work is exceedingly well done throughout, and it will undoubtedly take rank with the best works on electrical engineering that have been published. It contains a vast amount of information, much of it treated in a highly original manner, and generally with as much clearness as can be expected in a work of this character. The chapter on electrical measurements and on conductors for continuous and alternating currents are especially good, but in view of the extreme difficulty of the subject to all those who have not already had a technical training in electrical matters, we think they might have been improved by expanding them so as to contain numerical examples and some explanation in ordinary English of matters that are treated by the calculus. In fact we think the whole work might better have been given in two books, one including the earlier chapters which are easily understood by the constructor who has no mathematical training, and the other treating in much greater detail than the present work does of the matter requiring a knowledge of mathematics for its elucidation. It would be well if authors of works like this would consider that they are likely to have two classes of readers, one the small number who are expert in mathematics, and the other far larger number who are inexpert and who would wish to see conclusions stated in language that they can comprehend. Both classes might be suited if after deducing a differential equation and obtaining the final formula in Algebraic form a restatement were made with an arithmetical example. In the present work it frequently appears as if the author in endeavoring to prevent his book from growing too large had erred in the direction of too great conciseness. For example, in one place he states that ohmic resistance should be multiplied by a certain factor to obtain virtual resistance, but he does not explain what is meant by the term "ohmic" and "virtual." Again he speaks of "frequency" without explaining that it means the number of complete alternations in one second. We note a few trifling errors which may be corrected in the next edition, viz., on p. 4, second line from bottom, "elasticity" is used for "ductility"; on p. 315, last line, "magnetic pole" should be "unit magnetic pole." On p. 6 it is stated that joint meetings of the Iron and Steel Institute of Great Britain and of the American Institute of Mining Engineers resulted in the establishment in England of the Imperial Standard Wire Gage and in the adoption in this country of the Brown & Sharpe Gage. The facts are that these two societies never had a joint meeting except in 1890, while the Imperial Standard was made the legal gage in Great Britain in 1884, the Brown & Sharpe gage has been adopted by copper and brass wire makers in this country for a great many years, and was never adopted by the American Institute of Mining Engineers, which Institute, by the way, never adopts anything. The typography and illustrations of the book are excellent, and on the whole it can be highly recommended to every electrical engineer and student.